On Children

Child Health Status and Risk Factors

Barbara Starfield and Peter P. Budetti

OVERVIEW

HEALTH STATUS

Mortality

Death in childhood is rare. Reductions in infant and child mortality represent one of the major accomplishments of our society. Nevertheless, several disturbing trends are apparent. Low birth weight is by far the most important correlate of infant mortality, particularly neonatal mortality. There is a dearth of information regarding the relative importance of prematurity and intrauterine growth retardation in the population as a whole, as well as for groups at high risk. Infants from socially disadvantaged families die at much higher rates than other infants, even though death rates have generally been declining. Infectious diseases and injuries are a major component of the excess mortality in the postneonatal period; the United States has more deaths from those causes than other industrialized countries, but little is known about the reasons for this. Violent deaths in childhood, resulting from injuries and homicide, present a very serious challenge for the future. In late adolescence and early adulthood, the growing number of suicides is yet another indication that serious problems remain to be solved.

Mortality data are presented here in three ways. First, the death rates for infancy, childhood, adolescence, and young adulthood are

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Address communications and requests for reprints to Barbara Starfield, M.D., M.P.H., Division of Health Policy, Johns Hopkins University School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, MD 21205. Peter P. Budetti, M.D., J.D. is currently Counsel, Subcommittee on Health and the Environment, U.S. House of Representatives; at the time this paper was prepared, he was Associate Professor of Social Medicine in Pediatrics, Institute for Health Policy Studies, School of Medicine, University of California, San Francisco.

presented, together with trends in death rates. Next, the major causes of death are discussed. Finally, the impact on society is discussed in terms of potential years of life lost due to the various causes of death.

Research attention is especially indicated in three areas.

First, marked changes in the rate of decline of infant mortality suggest that it is very sensitive to external factors. In the case of neonatal mortality, technological and organizational advances appear to have had a major impact in reducing the number of deaths, but the nature of this impact is poorly understood. In particular, the relative impact of these advances on infants at varying risk, especially with regard to prematurity versus intrauterine growth retardation, needs elucidation. In the case of postneonatal mortality, research is required to determine why the United States lags behind other highly developed nations, particularly with regard to deaths related to infections and injuries. The role of access to and quality of medical care, both in general and with particular focus on populations at greater sociodemographic risk, deserves attention in this regard.

Second, we must explore why morbidity in the first year of life among infants who are born small for gestation is greater than morbidity among infants who are small but appropriate for gestation. The extent to which these differences are due to or associated with major sociodemographic characteristics is unknown and deserves attention in research.

Third, two characteristics of childhood mortality deserve research attention: (1) we need to find out why mortality rates vary with sociodemographic status and to test interventions aimed at reducing mortality. The role of medical care, including both access and content, requires critical examination. (2) Studies of the cost-effectiveness of various approaches to reducing deaths from injuries, particularly active versus passive methods, are warranted.

Morbidity

Understanding the patterns of illness in childhood is a necessary step in setting priorities for provision of health services and for allocation of resources for research. A variety of types of data on child health exists, some of which provide a description of changes in child health status over time. Yet serious problems compromise the usefulness of data of almost all types, making it critical to understand and perhaps redesign many of the ways of collecting information on child health. Accordingly, this section begins with a description of the different sources of data, including their strengths and weaknesses.

Data on morbidity are most limited in infancy, but one major study does show the high frequency of major health problems within the first year of life: one in five infants suffers at least one major health problem, and one in ten is hospitalized during the first year. In early childhood, the complexity of health problems makes generalization very difficult, so we present the data from a variety of perspectives. Some recent work indicates that childhood illnesses tend to cluster in certain children and strongly suggests the need for new techniques to study the health of individuals over time. As is the case with childhood mortality, injuries are a major cause of childhood morbidity. Finally, some evidence suggests that children with at least some types of health problems are at greater risk of subsequent illness than other children.

Research in childhood morbidity is needed in two areas.

First, increased attention to the correlates of illness (including social, behavioral, and environmental, as well as biomedical correlates) is warranted, both to identify causative and predisposing factors and to identify factors that enhance or interfere with responsiveness to medical care interventions.

Second, a pressing need exists to develop and apply multifaceted measures of health status; these measures are necessary for examining and understanding the relationship of specific diagnoses to health states as reported by parents, teachers, and health professionals. Long-term studies should be initiated to provide an understanding of the prognosis of different states of health, whether or not they have currently known etiologies.

RISK FACTORS

For the purposes of this article, risk factors are divided into five groups: biological and genetic; sociocultural; medical care; behavioral; and environmental. Risk factors do not lend themselves easily to grouping. For example, maternal age may be considered a biological risk factor from the infant's viewpoint but a behavioral one from the mother's. Similarly, nutritional status may result from behavior, but social conditions and sociocultural background influence this behavior. Medical care is considered separately because it involves social conditions, sociocultural factors, and induced behaviors, all in a setting heavily influenced by genetic and biological factors and environmental determinants.

Risk factors can be subdivided further, into predisposing, mediating, and host factors. The complex relationship among these variables highlights an important aspect of risk factor analysis that must be kept

in mind: causation and association are not the same, yet identifying causes is critical for designing interventions. Causal relationships can be intricate and difficult to identify even where they exist. For example, social conditions can cause illness through at least three pathways, and interventions might be more or less effective at different points along those pathways (Figure 1). In addition, some relationships may be spurious and should not be candidates for interventions at all. These can be identified only through careful theoretical and empirical study.

We do not purport to offer an exhaustive analysis of child health and risk factors here. Not only are sufficient data lacking, but a thorough analysis of data that do exist would require years of work. What we present here is a guide to further research on the many complex issues of child health determinants and health services needs.

RESEARCH AGENDA

Research on children's health and risk factors must move its focus from specific diseases to people themselves. From the viewpoint of demand on health care resources, it is most important to understand (1) the factors predisposing to illness in general, the relationships among those factors, and the targets amenable to intervention; (2) the way in which the resulting patterns of morbidity produce functional disability and use of health services; and (3) the effects of individual and group factors on responses to therapy.

Research toward this end must incorporate three themes.

1. The development and application of generic measures of morbidity. Although such measures might include specific diagnoses, assessment of the impact of etiologic factors on ill health and of the impact of ill health on the need and demand for resources requires measurements of both biological and functional states resulting from interactions of coexisting health conditions in individuals. A multifaceted measure, including functional status, is needed. Morbidity is a major determinant of use of health services, whether measured by individual visits or by experiences over time. There is every indication that a relatively small proportion of the child population consumes a disproportionately large proportion of resources [1]. It is important to learn how to identify these children to determine ways of preventing or reducing their morbidity and to determine the most cost-effective approaches.

2. The development of a means for tracking the health of individuals in populations. Although this involves both repeated cross-sectional and longitudinal perspectives, it is the latter that requires

particular attention, because it has been largely neglected. Longitudinal studies are essential to understanding the impact of social and environmental risks that have long-term effects and to understanding the impact of health problems on subsequent demand for health care resources.

3. The development and application of better methods to examine the impact of medical care on functional status and its effectiveness in preventing future morbidity and disability. Although many methods have been devised to obtain information from clinical practices, they have not moved beyond the collection of minimal baseline information about care provided in private office-based practice. The capability for examining the impact of the care provided and for comparing the care across practices and different types of practices (including hospital- and community-based clinics as well as health maintenance organizations [HMOs] and private practices) is necessary. It is also important to explore the possibility that current medical practice aggravates the cycle of morbidity by creating diagnoses in individuals who present repeatedly with vague symptomatology.

Within the context of these three principles, the following specific research priorities emerge:

1. Studies of the efficacy, effectiveness, and efficiency of specific diagnostic and therapeutic interventions.

Studies of efficacy should precede studies of effectiveness. Further, because they are directed at particular kinds of therapies, diagnostic tests, and clinical conditions, studies of efficacy are best conducted by agencies such as the National Institutes of Health (NIH). Studies of the efficiency and effectiveness of service delivery, on the other hand, involve special techniques to assess the effect of a multiplicity of factors, including many nonbiomedical factors and factors that cannot be controlled; these are vital and are appropriately conducted under the aegis of a research agency such as the National Center for Health Services Research.

2. Studies of the differential impact of medical interventions and of organizational and financial innovations on populations at high risk of severe illness compared with populations at lower risk.

Much more use should be made of existing sources of data, such as the National Ambulatory Medical Care Survey (NAMCS), the National Hospital Discharge Survey (NHDS), and the various data sets of the state Health Services Cost Review commissions, to assess such impacts. These should be augmented by other, more targeted

efforts at practice-based reporting, perhaps conducted with the collaboration or under the aegis of professional organizations.

3. More prompt and more comprehensive analyses of existing and routinely collected data.

Much more information can be gleaned from the annual National Health Interview Survey (NHIS), the periodic Health Examination Survey (HES, now the National Health and Nutrition Examination Survey [NHANES]), and the continuing National Hospital Discharge Survey. In the future, surveys should include a subsample involved in a prior survey. This was done for a subsample of children examined in Cycle I of HES; these children were reexamined in Cycle II, but only a few analyses of these data have been conducted [1]. The institution of representative longitudinal data collection might well start with this type of activity. Specific areas that warrant priority include the following:

- Prompt preparation and release of public use data tapes, such as the 1981 Child Health Supplement to the National Health Interview Survey, the annual tapes from the continuing surveys, and support for extramural analyses of these data sets
- Comparisons of data from the National Hospital Discharge Survey with data collected by the state cost review commissions and by efforts such as the Professional Activities Survey to determine where they overlap, complement each other, and differ from one another
- Development and application of methods to make the National Hospital Discharge Survey useful for population estimates even when analyzed by available sociodemographic variables (such as payment source)
- Linkage of data sets to geographic areas for which there is information on sociodemographic characteristics (for example, census tract or zip code)
- Augmentation, perhaps on a sample basis, for studies of representativeness or for studies of small area differences
- Analyses of data to permit the description and examination of comorbidity
- Expansion of the National Ambulatory Medical Care Survey to include sampling of all major sites in which ambulatory care is delivered, not simply office-based medical practices

- —Development of ambulatory care data sets on defined populations over time (Prepaid group practices and HMOs are ideal sources of such data sets: because of their enrolled populations, they could contribute significantly to knowledge about the distribution of illness and the impact of medical care and other factors on its prognosis.)
- —Development of data linkages, particularly among data sets with information on hospitalizations, Medicaid files, public health departments, and clinical sites in the community
- —Development and application of measures of health status that are multifaceted and could examine the relationship of specific diagnoses to health states as reported by parents, teachers, and health professionals (This could be accomplished by correlating various components of the National Health Survey—for example, the same population cohort could be studied in the interview (NHIS), examination (NHANES), and ambulatory care (NAMCS) surveys as a reference for the significance of findings across studies.)

4. Adoption by researchers of a more consistent policy for including major social and environmental variables in studies of the etiology and response to intervention of particular illnesses.

All studies should include as a minimum some measure (and preferably several measures) of social status, especially family income, and all should collect data in a way that permits residence to be assigned to some geographic area with known characteristics (such as census tracts or, where appropriate, zip codes). This is important because environmental hazards are increasingly recognized as having an impact on health. Analyses of data using interactive models that explore the impact of various combinations of risk factors [2] should be standard in research, and the application of a conceptual scheme such as that used for understanding risk of injury [3] should be encouraged in the design and conduct of studies.

5. Encouragement of the widespread use of standard minimum data sets in ambulatory care practice.

If practitioners who collect such data collaborated and analyzed their data quickly, they could provide critical information on the distribution of illness and its management. The National Ambulatory Medical Care Survey provides an important baseline for this effort, but it must be supplemented by more specific information.

6. Prospective design and independent management of evaluations of major health care demonstrations.

Although there is extensive private and public funding for demonstration projects, rarely are they evaluated adequately. To learn from demonstration projects requires an evaluation program that is designed prospectively, that is mandatory for providers, and that is conducted by independent analysts.

HEALTH STATUS

MORTALITY

Although death rates for infants, children, and young adults generally have been declining to impressively low levels, and these developments represent one of the major accomplishments of our society, nevertheless, there is no room for complacency: within each age group, and cutting across age groups by race, one can easily identify serious problems that must be addressed.

Infant mortality, usually measured as the number of deaths per 1,000 live births, has fallen dramatically over this century [4–6]. The current rate is approximately one-ninth of what it was in 1915. This means that only about 11 babies of each 1,000 who are born will die during the first year of life, compared with nearly 100 babies in 1915.

Infant mortality has two major components: deaths during the first 28 days (neonatal mortality) and deaths during the remaining 11 months of the first year (postneonatal mortality). Both neonatal and postneonatal rates have been declining during the past 70 years, but with somewhat different patterns.

Before 1930, postneonatal and neonatal deaths contributed approximately equally to infant mortality. During the 1930s and 1940s, postneonatal rates declined much more rapidly than neonatal deaths [7]. By 1955, the postneonatal rate had fallen to about one-seventh of the earlier figure, but the neonatal rate had declined by only about one-half. By that time, the postneonatal rate had reached such low levels that, although it has generally continued to decline, it no longer contributes as much to the reduction in infant mortality as the neonatal rate has in recent years. In fact, the neonatal rate has fallen by more than one-half since 1970, a truly remarkable continuing decline.

Although these rates are impressively low, the first year of life still has the highest death rates until age 65 and over [8]. Moreover, three of six of the leading causes of infant mortality, accounting for over one-

fifth of all infant deaths, occur almost entirely among infants with low birth weights [9].

Postneonatal mortality rates in the United States are higher than in many other industrialized nations. This is a result of higher death rates from infectious diseases (particularly respiratory diseases), accidents (including sudden infant death syndrome), and ill-defined diseases [10].

Death rates in early childhood, between the ages of 1 and 4, have also declined approximately tenfold since 1925 [11]. Again, much of this reduction occurred before the mid-1950s, but rates have continued to fall since that time. Since 1965, the rate has fallen by one-third, from just under 100 deaths per 100,000 preschool-age children to about 60.

For children and youths age 5 through 14, the declines have been substantial but not quite as impressive as for the younger ages. Since 1925, overall mortality rates have fallen to about one-sixth of their earlier level [11]. Overall, infant mortality and death rates for children under 15 declined about 2 percent per year between 1950 and 1970 [12]. By 1977, infant mortality was declining at about 5 percent per year, while the rate for other children under age 15 was falling at about 3 percent [12].

The situation for adolescents and young adults, age 15 through 24, is quite different and much more worrisome. Bauer and Wilson [8] pointed out that "unlike Americans in every other age group, the death rate for the 40 million adolescents and young adults is higher today than it was 20 years ago." (p. 21) The pattern of deaths in this age group shows that the rate declined substantially between 1950 and 1960 but rose again during the 1960s and stayed constant through the early 1970s. Since then, death rates have declined but still remain above the level reported for 1960. Table 1 illustrates the marked differences by sex and race for deaths in this age group.

The declines in death rates are paralleled by reductions in certain causes of death. Between 1970 and 1978 (the last year in which the old International Classification of Diseases [ICD] was used), nearly all of the leading causes of infant mortality showed impressive declines; the exception was deaths from birth injuries, which showed only a small decline [9]. Subsequent reports, based upon the new International Classification of Diseases, Adapted-9th Revision (ICDA-9), show continuing declines in deaths due to birth trauma. Only septicemia has shown an increase, presumably because babies with other serious problems are surviving long enough to succumb to overwhelming infection [4].

Between ages 1 and 4, injuries have remained the leading cause of

Table 1: Death Rates by Age, Race, and Sex: United States, 1950, 1960, and 1970-81*

Race, Sex, and Year	*All Ages*	*Under 1 Year*	*1-4 Years*	*5-14 Years*	*15-24 Years*	*Under 1 Year*	*1-4 Years*	*5-14 Years*	*15-24 Years*	*Under 1 Year*	*1-4 Years*	*5-14 Years*	*15-24 Years*
Total							White				All Other		
1981 (est.)	866.4	1,190.4	60.2	30.7	107.7	1,063.0	55.7	29.5	104.6	1,703.3	80.1	35.8	124.1
1980 (est.)	874.1	1,269.0	64.1	30.7	115.6	1,088.1	58.2	29.7	112.3	2,070.3	91.3	35.4	133.6
1979	852.2	1,332.9	64.2	31.5	114.8	1,135.5	57.5	30.1	111.8	2,260.6	95.6	38.3	130.9
1978	858.0	1,381.4	67.9	33.2	115.0	1,169.2	61.2	31.5	111.6	2,405.1	99.9	41.5	133.6
1977	864.4	1,432.6	67.6	34.0	114.8	1,221.4	61.1	32.4	110.8	2,455.6	98.5	41.6	137.6
1976	877.6	1,549.4	68.8	34.2	111.7	1,320.1	62.8	32.7	106.0	2,670.8	97.5	41.8	144.2
1975	878.5	1,603.0	69.9	35.2	117.3	1,377.0	63.3	33.4	110.0	2,733.7	101.4	45.1	159.6
1974	906.7	1,721.9	73.3	37.8	120.3	1,498.2	66.4	36.1	111.7	2,831.8	107.7	47.0	171.3
1973	933.5	1,776.9	79.0	40.7	127.1	1,545.9	70.9	38.4	117.5	2,916.7	120.9	52.8	184.9
1972	938.4	1,820.4	80.4	40.6	126.9	1,572.4	72.9	38.9	115.5	3,090.9	120.0	49.7	197.4
1971	932.0	1,887.8	82.3	40.9	126.1	1,643.3	74.0	38.6	113.3	3,193.5	126.8	54.2	208.0
1970	945.3	2,142.4	84.5	41.3	127.7	1,869.7	75.1	39.1	115.8	3,597.1	134.1	53.7	203.6
1960	954.7	2,696.4	109.1	46.6	106.3	2,357.7	95.2	43.9	99.1	4,626.4	190.8	64.3	158.2
1950	963.8	3,299.2	139.4	60.1	128.1	2,992.6	124.1	56.4	111.7	5,368.4	250.8	86.0	251.3
Male													
1981 (est.)	961.6	1,344.8	68.2	38.6	159.2	1,193.9	62.4	38.0	154.6	1,956.0	94.9	41.4	183.8
1980	976.9	1,428.5	72.6	36.7	172.3	1,230.3	66.1	35.0	167.0	2,350.2	103.0	44.9	201.6
1979	957.5	1,482.0	71.0	38.4	171.0	1,276.0	64.2	36.6	167.0	2,468.0	103.7	47.1	193.6
1978	977.5	1,532.8	76.7	40.5	169.4	1,302.9	69.9	38.3	164.8	2,652.2	109.2	51.8	195.8
1977	978.9	1,599.7	75.2	41.8	169.2	1,377.4	68.1	39.7	164.0	2,692.3	109.2	52.4	199.5
1976	993.8	1,715.0	76.9	41.9	164.8	1,473.1	70.5	40.0	156.8	2,921.8	108.3	51.8	212.1
1975	1,002.0	1,786.2	76.7	43.3	174.1	1,551.9	70.1	40.9	163.6	2,967.3	109.4	56.2	237.6
1974	1.031.5	1,931.5	81.5	46.4	178.9	1,695.3	74.5	44.2	166.6	3,125.9	117.3	58.3	254.3

1973	1,065.2	2,001.6	88.2	49.6	187.8	1,756.5	79.2	46.6	174.5	3,222.6	135.4	66.5	271.3
1972	1,074.9	2,055.1	89.4	48.6	186.7	1,796.6	81.9	46.7	169.5	3,402.2	129.7	59.2	296.6
1971	1,069.4	2,121.4	90.6	49.3	185.4	1,860.8	81.6	46.2	166.4	3,534.5	139.3	66.5	310.3
1970	1,090.3	2,410.0	93.2	50.5	188.5	2,113.2	83.6	48.0	170.8	4,020.0	144.7	65.0	304.6
1960	1,104.5	3,059.3	119.5	55.7	152.1	2,694.1	104.9	52.7	143.7	5,189.4	207.3	75.2	213.8
1950	1,106.1	3,728.0	151.7	70.9	167.9	3,400.5	135.5	67.2	152.4	5,991.6	271.2	97.1	289.9
Female													
1981 (est.)	776.5	1,029.1	51.7	22.4	55.2	924.8	48.7	20.7	53.2	1,443.5	65.0	30.2	65.7
1980	785.3	1,141.7	54.7	24.2	57.5	962.5	49.3	22.9	55.5	1,944.1	79.5	29.8	68.0
1979	752.7	1,176.6	57.0	24.3	57.6	986.7	50.4	23.2	55.2	2,049.7	87.4	29.3	70.4
1978	764.5	1,222.7	58.8	25.6	59.6	1,027.5	52.0	24.4	57.0	2,151.8	90.4	31.2	73.7
1977	756.0	1,257.0	59.7	25.8	59.6	1,056.7	53.7	24.8	56.3	2,213.0	87.6	30.7	78.0
1976	767.6	1,375.2	60.4	26.1	57.7	1,159.0	54.8	25.0	54.0	2,425.3	86.5	31.8	78.8
1975	761.4	1,410.9	62.7	26.8	59.8	1,191.7	56.2	25.5	55.3	2,493.8	93.3	33.8	84.9
1974	788.3	1,502.1	64.6	28.8	61.1	1,290.4	57.8	27.6	55.7	2,541.9	97.9	35.6	92.0
1973	808.3	1,542.2	69.4	31.3	65.9	1,324.8	62.1	29.9	59.6	2,603.8	106.4	39.0	102.7
1972	808.7	1,575.3	71.0	32.2	66.9	1,337.1	63.4	30.7	60.8	2,773.9	110.3	40.2	103.0
1971	801.4	1,642.9	73.8	32.3	67.2	1,414.2	66.0	30.6	60.1	2,845.2	114.2	41.8	111.4
1970	807.8	1,863.7	75.4	31.8	68.1	1,614.6	66.1	29.9	61.6	3,169.4	123.3	42.3	108.8
1960	809.2	2,321.3	98.4	37.3	61.3	2,007.7	85.2	34.7	54.9	4,067.1	174.4	53.4	106.1
1950	823.5	2,854.6	126.7	48.9	89.1	2,566.8	112.2	45.1	71.5	4,749.0	230.3	75.0	216.4

Source: National Center for Health Statistics Monthly Vital Statistics Reports [5].

*For 1981, based on a 10 percent sample of deaths, for all other years, based on final data. Rates per 100,000 population in specified group.

death since the early 1900s; other major causes of death have shifted from infectious diseases to noninfectious conditions such as cancer and congenital defects [13]. Physical injuries due to accidents and other violence have played an increasing role and now account for between one-third and one-half of all deaths in this age group. Deaths from accidents other than motor vehicle accidents have fallen substantially since 1925, but the homicide rate even in this young age group has increased approximately fivefold since 1955. Rates of death from congenital anomalies are similar to the rates cited for the early part of this century, after a brief rise between 1940 and 1960. Deaths caused by malignant neoplasms, particularly leukemia, have declined substantially since the middle 1950s after an earlier reported rise. Deaths from diseases of the heart declined substantially between 1925 and 1950, then leveled off until 1970, when they began to show a small rise.

Children and youths age 5 through 14 show patterns fairly similar to those of the younger children. Motor vehicle accidents in this age group have remained fairly constant after declining between 1925 and 1950, and they are now the leading cause of death [11]. Homicide and suicide rates have increased somewhat. Malignant neoplasms and leukemia both show a decline following a small rise. A similar pattern is observed for congenital anomalies. Diseases of the heart show striking improvement, with an eightfold reduction between 1925 and 1950, and continuing low levels since that time—at least partly due to declines in rheumatic fever.

Death rates for adolescents and young adults are somewhat more worrisome. One cause of concern is the increasing trend toward suicide, which is much greater in the 15–29 age group than among adults in subsequent age groups [14]. Injuries, particularly in motor vehicle accidents, account for well over one-half of all deaths in the 15–24 age group [4, 6]. Homicide and suicide both have strikingly high rates, each accounting for about one of every seven or eight deaths in this age group. Taken together, physical injuries, homicide, and suicide account for 78 percent of all deaths among adolescents and young adults age 15 through 24. The leading fatal disease, malignant neoplasms, accounts for less than 5 percent of all deaths, while heart disease has a rate approximately one-half that of malignant neoplasms.

Death rates and leading causes of death provide very useful information but may understate the importance of childhood deaths. Another way of looking at the importance of deaths in childhood is to consider the potential years of life that are lost [15, 16]. This approach "gives simple statistical expression to the harsh reality of death at younger ages" [15]. McGinnis [17] has ranked the top five causes of years of

life lost for ages 1 through 64 and 1 through 74. Cancer and diseases of the heart, which are more prominent in the older age groups, are well behind physical injuries in the younger groups. Similarly, homicide and suicide are substantial factors in the loss of potential years of life.

Perloff et al. [18] have extended this concept to potentially productive years of life lost. Their figures show that injuries, homicide, and suicide account for nearly 30 percent of all potentially productive years of life lost, considering all causes of death among every age group. The impact on society of these violent deaths is impressive. Similarly, perinatal conditions and congenital abnormalities contribute substantially to the loss of potentially productive years of life. Other major causes are the leading causes of death—malignant neoplasms, diseases of the heart, and cerebrovascular diseases.

MORBIDITY

Gathering and interpreting data on morbidity in childhood are motivated by the need to set priorities in both the provision of health services and resources for research. Although these imperatives are often in conflict, the guiding principles should be (1) to describe the distribution of all illnesses in the population, (2) to determine the extent to which preventive and therapeutic modalities are adequate in dealing with them, and (3) to allocate resources according to judgments about the frequency and impact of the conditions, their preventability and controllability with current knowledge, and the need for new knowledge that would help in their prevention and control. In this section, we deal with the distribution of all health problems in childhood. The traditional dichotomy between acute and chronic conditions is maintained only where the data are unavailable in another form, as it is increasingly evident that some conditions long considered acute and self-limited tend to recur.

Measurement of Morbidity

The availability of several types of data, many of very high quality, makes it possible to obtain information on at least some aspects of changes in child health over time. The National Center for Health Statistics collects and analyzes various types of data in the various components of the National Health Survey. These include natality and mortality statistics that provide information on birth rates and death rates by cause and by a variety of sociodemographic variables. Studies using these data, and augmented by special surveys (such as the follow-back natality survey) and data linkages, have been responsible for

important advances in knowledge about the causes and correlates of health problems (for example, see [20]).

These national data, although available for surveillance, are infrequently analyzed in detail specifically for children. They are even more infrequently analyzed to address specific questions such as those concerning changes in access to care or the impact of health care programs. A brief discussion of the national surveys follows.

The ongoing National Health Interview Survey (NHIS) provides information on utilization of health services and on particular aspects of perceived health status. This information has greatly improved knowledge about the differences in health behavior and health of different sociodemographic groups (see, for example, Kovar [20]). Each week a probability sample of households is interviewed by trained personnel of the U.S. Bureau of the Census. Over the course of a year, interviews are conducted in approximately 42,000 households, which include about 30,000 children under age 18.

The Health Examination Survey (subsequently entitled the National Health and Nutrition Examination Survey, or NHANES) is conducted periodically and provides information on health status as determined by a physician's examination and laboratory tests as well as through an interview.

The National Hospital Discharge Survey (NHDS) provides information on the frequency and length of stay in hospitals for particular diagnoses for a representative sample of hospitals according to their geographic region.

Data from the National Ambulatory Medical Care Survey (NAMCS) provide information about the frequency of conditions and characteristics of their diagnoses and management. However, this survey is limited to office-based practices and excludes institutional facilities, which serve disproportionately large numbers of disadvantaged populations.

Augmenting these sets of data are national surveys conducted by nongovernmental groups. Some of these surveys have been repeated over time and provide large amounts of information that improve our understanding of the determinants of care seeking and correlates of perceived health status (for example, see [21]).

Each of these sources of data contributes uniquely to knowledge about the health of a representative sample of the population. Moreover, their design permits population estimates to be made not only for the entire population sampled but for important subgroups of the population.

In addition, the Centers for Disease Control (CDC) maintains an

ongoing surveillance over conditions of major public health significance, such as communicable diseases.

There are other important sources of data about certain aspects of health status and utilization of services. All states and local jurisdictions collect vital statistics, although not all do so in a manner that enables policymakers to identify problems in important subgroups of the population. This is particularly true with regard to data on the poor; as a result, "nonwhite" is frequently used as a proxy for poverty, even though it is clearly an inadequate substitute for direct information on income. Data collection efforts such as the Professional Activities Survey (PAS) and the Children's Hospitals Automated Medical Program (CHAMP) provide useful information on frequency of diagnoses in hospitals and certain aspects of care in hospitals, but the data are not representative of the population because they are provided only by those hospitals that subscribe to these services.

Unfortunately, most of the large representative national data sets do not provide the data needed for making policy at the local level. One problem is that sample sizes (as for the NHIS and NHDS) are too small, particularly if data on population subgroups are required. In the case of routinely collected natality and mortality data, national data tapes do not contain the information that would be required to assess changes associated with compromised access to medical care (such as increasing poverty or unemployment). Most important, none of the data sets (with the exception of the NHDS, which cannot provide information in areas smaller than the nine major geographic regions) contains information on important but generally nonfatal specific health conditions in defined population subgroups. This produces a particular dilemma in policymaking for children, for whom a much greater proportion of problems is nonfatal than is the case for adults.

Three additional problems compromise the usefulness of data of almost all types [22].

1. Failure to include important social and environmental variables in analyses. Despite the great increases in knowledge about biological correlates of illness that have resulted from research in the last three decades, knowledge about the etiology of most disease is still inadequate. Yet most epidemiological studies still fail to include variables such as social class, area of residence, type of occupation, education, and relevant behavior, such as nutritional practices, smoking, and preventive activities.

2. Lack of an adequate classification system for most morbidity, creating difficulties in describing health problems in the population [23]. The standard classification scheme, ICD, was developed to code

causes of death; even its adaptations make it suitable primarily for classifying diagnoses in hospitalized patients. Recent schemes for coding morbidity as it exists in ambulatory care practice, such as the International Classification of Health Problems in Primary Care (ICHPPC), are promising, as are systems for coding problems as they are reported directly by patients (the National Center for Health Statistics "reason for visit" classification). These latter two systems are not widely used, however, and as a result it is not generally possible to compare the distribution of morbidity as assessed by surveys in different communities or at different times.

3. Fragmented data collection and analysis resulting from the distinct and separate agendas of health systems oriented toward particular health problems or types of health problems. Each of several agencies collects information about the frequency and impact of specific problems. The resulting data provide a view of the frequency of presentation of individual problems but they provide little information on the proportion of individuals affected, the types of individuals who are afflicted with health problems, or the burden of morbidity resulting from combinations of problems.

INFANCY

Very little information about the health of infants is available. Most surveys, whether they are by household interview or other techniques, are unable to provide such information because of the small number of infants who can be included in them. The HES did not include children under the age of 6 and the NHANES did not include children under age 1.

The most nearly complete recent data on the health status of infants comes from an evaluation of a project to regionalize perinatal care. In this survey, which was conducted in the home, a stratified random sample of 4,738 1-year-olds (who were single, live births) was assessed for eight geographic areas. Almost 1 in 50 (2.0 percent) singletons had severe impairment (either a congenital anomaly or a marked delay in development). Another 7 percent had moderate impairment from a congenital anomaly or developmental delay, and another 4 percent had a congenital anomaly not likely to produce permanent or significant impairment [24]. Even children without congenital anomalies or developmental delay may experience morbidity: of such otherwise normal children, 6 percent were hospitalized within their first year and another 4 percent had an illness lasting at least a month or a

condition requiring prolonged medical care [25]. In total, 9.1 percent of all infants surviving to 1 year of age had been hospitalized at least once. Approximately one in six of these admissions was due to congenital anomaly or developmental delay, one-third to lower respiratory tract problems, one in five to gastrointestinal problems, and one in ten to upper respiratory problems. The remainder were a result of accidents or other medical problems [26].

Thus, at least one in five singleton infants has at least one major health problem within the first year of life, and one in ten is hospitalized during that period. Because infants who were one of a multiple birth are more likely to have subsequent problems, the frequency of problems among that population is undoubtedly higher than reported here. Infants with low birth weights are more likely to have problems in their first year than are other infants. This is especially true for infants who are born small for their gestational age [25], but the extent to which this results from other, confounding factors is unknown.

CHILDHOOD

No one method is sufficient to describe the frequency of health problems in childhood. Some problems are known only to parents or families, because they are not manifested outside the home and are not brought in for medical care. Some are noticed only by teachers, who observe children under different circumstances than do their parents. Some health conditions become known only upon special questioning by qualified personnel, and some require a physician's assessment for their diagnosis.

In this section, we describe the frequency of morbidity according to the source of information: household interviews of parents, community and school surveys, health examination surveys, and physician practices. No one has yet compiled and published data on the prevalence of conditions for which children are hospitalized, although data from the NHDS are available.

HOUSEHOLD INTERVIEW SURVEYS (NATIONAL)

Information reported by family members (generally the mother) is useful only to the extent that it is obtained reliably. The NHIS has been collecting information for over two decades with an instrument that has withstood tests of reliability and validity.

The NHIS collects parental assessments of the overall state of the

child's health, reports of acute conditions and restricted activity associated with them, and limitation of activity due to chronic conditions and the chronic condition associated with this limitation.

In 1978, about 60 percent of children, regardless of age, were reported to be in excellent health, about 35 percent in good health, about 4 percent in fair health, and about 0.5 percent in poor health [27]. In 1976, 18.6 percent of children age 7 to 11 were said to have a current health problem that bothered the child or worried the mother, even though at that time only about 4 percent of children were reported to be in poor or fair health [28].

In 1981, children under 6 had an average of 3.8 acute conditions per child per year; for ages 6 to 16, the figure was 2.8. Injuries, which by definition received medical attention or reduced the child's normal activity by at least one full day, accounted for 9.7 percent of acute illnesses before age 6 and 14.6 percent for ages 6 to 16. They were the second most frequent type of illness for ages 6 to 16 (after respiratory illnesses, which accounted for 51.4 percent of all acute illnesses) and the third most frequent for children age 5 and under (after respiratory illnesses, 52.4 percent, and infectious diseases, 15.7 percent [27].

An estimated 7.3 million children under age 6 and 14.8 million between 6 and 16 were injured. Most injuries occurred at home (57 percent and 36 percent, respectively), although for ages 6 to 16 the "other" category (not including motor vehicle or home injuries) accounted for most of the injuries (59 percent). The proportions of persons with injuries as reported in this survey were 36.2 for children under age 6 and 38.2 for ages 6 to 16 [27].

In 1981, children under age 6 had an average of 10.7 days of restricted activity due to acute illness per person per year; children age 6 to 16 had 8.3 such days. Injuries alone accounted for 0.4 and 1.5 of these days, respectively. The average number of days lost from school due to acute illnesses was 4.37 per child. Of these, 2.53 (58 percent) were due to respiratory illness, 0.84 (19 percent) were due to infectious diseases, 0.37 (8 percent) were due to injuries, 0.20 (4.5 percent) were due to digestive conditions, and 0.43 (10 percent) were due to other acute conditions. The average number of schooldays lost in 1981 due to both acute and chronic conditions was 4.9 [27].

Of children under age 17, 3.8 percent were reported to be limited in their activity due to a chronic condition. Two percent were limited in their major activity (going to school for school-age children, and engaging in ordinary play with other children for preschool-age children), and another 1.8 percent had a limitation other than in their major activity. These percentages reflect the twofold increase in the

Table 2: Prevalence of Selected Chronic Conditions Among Children Under 17 Years of Age, U.S. 1970–73*

Condition	*Prevalence (1,000s)*	*Rate (per 1,000 Persons)*
Asthma	2,075	31.1
Bronchitis	2,592	38.9
Sinusitis	1,917	28.7
Hay fever	2,291	34.3
Hypertrophy of tonsils and adenoids	2,994	44.8
Eczema	1,962	29.3
Congenital anomalies of the heart	382	5.9
Rheumatic heart disease	51	0.8
Visual impairments	623	9.4
Hearing impairments	863	13.0
Speech impairments	995	15.0
Orthopedic impairments (including absence and paralysis)	1,844	27.7
Anemia	509	8.0
Epilepsy	188	2.9

*Source: Unpublished data from the National Health Interview Survey, National Center for Health Statistics (undated mimeograph).

rate of reported limitation due to chronic illness among children over the last 20 years [29].

Table 2 provides information on the prevalence of selected chronic conditions in children in 1970–1973 (the latest data available), and Table 3 provides information on disability associated with some of the conditions.

COMMUNITY AND SCHOOL SURVEYS

The cumulative burden of medically verified chronic diseases in an entire community of children up to age 16 was shown in a study conducted in Erie County, New York, in the late 1950s [30, 1]. Only certain conditions were considered in this study. For the most part, they are biological, permanent, and nonfatal. One child in 500 had one of these conditions. Not included were most malignancies, congenital anomalies, developmental aberrations, mental deficiency, and chronic conditions of uncertain permanence (such as asthma).

In a survey of an entire county (Monroe) in upstate New York in 1967 and 1968, parents were asked to report the presence or absence of a large number of chronic conditions in their children. Parents who had judged their child's conditions to be serious or somewhat serious were asked about the presence of impairment or chronic condition

Table 3: Prevalence of Selected Chronic Respiratory Diseases Among Children Under 17 Years of Age, United States, 1970*

Disease and Family Income	*Rate (per 1,000 Persons)*	*Received Medical Attention in Past Year (%)*	*Spent Days in Bed in Past Year (%)*	*Disability Days per Case*		
				Total	*Bed Days*	*Schooldays Lost*
Bronchitis						
Total	38.9	81.1	59.0	5.3	3.0	1.4
<$5,000	33.6	79.9	57.7	11.4	8.3	3.5
5,000 +	40.9	81.7	58.8	4.1	2.0	1.1
Asthma						
Total	31.1	68.0	43.6	14.3	5.8	3.1
<$5,000	32.3	66.8	47.3	17.4	8.7	8.9
5,000 +	30.8	69.0	42.6	13.8	5.2	1.8
Hypertrophy of tonsils and adenoids						
Total	44.9	81.7	65.5	8.4	4.4	3.1
<$5,000	42.5	73.3	57.8	11.3	7.5	5.3
5,000 +	46.1	83.2	67.1	7.8	3.7	2.7
Chronic sinusitis						
Total	28.7	42.1	21.9	3.3	2.2	1.4
<$5,000	21.9	42.9	23.5	5.2	4.1	3.4
5,000 +	30.0	41.8	21.8	3.1	2.0	1.2
Hay fever						
Total	34.3	45.2	7.6	2.8	1.0	1.0
<$5,000	20.0	36.0	17.3	7.8	2.7	2.5
5,000 +	38.3	46.6	7.0	2.3	0.7	0.8

*Source: Unpublished data from the National Health Interview Survey, National Center for Health Statistics (undated mimeograph).

using questions similar to those used in the NHIS. There are marked differences in the prevalence of conditions between this survey and the 1961 study in Erie County. Although the reasons for the discrepancy are not known, several factors might be at least partly responsible. These include differences in the method of ascertainment, differences in population, differences in medical care facilities, which result in different awareness of diagnoses among parents, and differences associated with improved access to medical care (and hence medical diagnosis) that occurred in the mid-1960s. Some support for the latter possibility is provided by data showing an increase in diabetes between the late 1950s and the 1970s in a population group whose access to care was improved during that interval of time (that is, poor children) [31]. However, the magnitude of the differences between the two surveys, as well as between the two surveys and data from the NHIS suggests that methodological factors play a substantial role.

Sternleib and Munan [32] documented the nature of personal and health problems reported by approximately 1,400 youths between the ages of 15 and 21 in Sherbrooke, Quebec. Nervousness and dental problems were the most common health problems (29 percent and 27 percent, respectively). Brunswick [33] provided data from a survey of black youths in Harlem, New York City, in 1968–1970, when they were 12 to 17 years old, and again 6 to 8 years later, when they were 18 to 23 years old.

Special surveys are also required to determine health problems manifested primarily in schools. In a 1976 survey of a national random sample of 7- to 11-year-olds, teachers reported 30 percent to be in excellent health, 38 percent in very good health, 26 percent in good health, 5.2 percent in fair health, and 0.5 percent in poor health. Six percent were reported to have 20 or more days of school absence in the previous school year; 11.8, 5.9, and 13.3 percent, respectively, were reported to have a physical, emotional, or mental condition that limited their ability to do regular school work or to take part in sports or other play activities, or both [28]. This survey showed that, although resources were more available and more often used in 1976 than they had been 15 years previously, in general only about half of the children with specific handicaps were receiving school services for them [28].

Special surveys conducted by the CDC provide information on the percentage of children who are adequately immunized against communicable diseases. Fewer than two-thirds of all children have received their immunizations before they first enter school, although they should have received them by age 2 [34, p. 36].

Most diseases, both those preventable and those not preventable

by immunization, have declined in frequency; but one in particular (gonorrhea) has increased over the last 20 years [11, Table 58].

Community surveys and school surveys have also been the major source of information about the prevalence of psychosocial problems in children. As will be noted below, there are no routinely reported data from hospital or community clinics. Data for office-based practice fail to capture the extent of mental health problems, for a variety of reasons [35].

The extent of behavioral disorders among the general population is unclear, largely because of the lack of standardized tools for measuring deviations from the norm that have prognostic significance. A related problem is the difficulty of defining "behavioral problems"—some are phenomena that others might consider to be social. For example, the "new morbidity" includes not only affect and conduct disorders, but also learning problems, problems in development and sexual maturation, environmental hazards, poor dietary habits, drug and alcohol addiction, and venereal disease.

In a national telephone survey of mothers, the Task Force on Pediatric Education [36] discovered that one in seven mothers of preschool children reported a problem in growth or development, and one in ten reported a difficulty in behavior or discipline. Fifteen percent of children age 5 to 14 are reported to have problems in social relationships. At ages 15 to 19, suicide is the fourth leading cause of death. In 1974, 2 of every 1,000 children age 11 to 14 and almost 7 per 1,000 of those age 15 to 17 were arrested on suspicion of a crime of violence (murder, nonnegligent manslaughter, forcible rape, robbery, or aggravated assault) [37].

The Joint Commission on Mental Health of Children [38] defined an emotionally disturbed child as one who is impaired in (1) accurately perceiving the world around him or her, (2) controlling impulses, (3) achieving satisfying and satisfactory relations with others, (4) learning, and (5) any combination of these. The commission estimated that 0.6 percent of children are psychotic, 2 to 3 percent are severely disturbed, and an additional 9 to 10 percent are afflicted with emotional problems and need specialized services. Fewer than 10 percent of the children who need these services are getting them.

Studies of the prevalence of specific behaviors or traits thought to be evidence of psychosocial problems are consistent in showing a frequency of at least 10 percent. Tuddenham et al. [39] reported mothers' descriptions of approximately 3,000 9-, 10-, and 11-year-old children in a defined population of children enrolled in a prepaid group practice. Mothers were asked about the presence of 100 behavioral traits.

The prevalence of selected items for boys and girls (respectively) was (1) frequent nightmares, 6 and 8 percent; (2) trouble getting to sleep, 12 percent for both; (3) bedwetting, 15 and 6 percent; (4) thumbsucking, 6 and 11 percent; (5) stammering, 3 and 1 percent; (6) fearfulness and frequent worrying, 12 and 11 percent; (7) loneliness, 9 and 8 percent; (8) outbursts of temper, 19 and 10 percent. The authors compared their results with those of previous studies and with the findings of a national sample of children studied in the HES of the National Center for Health Statistics (NCHS) and found generally similar prevalence rates despite differences in study technique and passage of time. The absence of clear trends, despite major changes over several decades in family life-styles, patterns of child rearing, and sources of tension, led the authors to conclude that stress in childhood is expressed in a finite repertoire of behavioral problems. Similar data on the prevalence of specific behavioral traits for children of ages between 6 and 17 are provided in other NCHS publications [40].

HEALTH EXAMINATION SURVEYS

Several national surveys have been conducted in which child health has been assessed by physician examiners, for example, the Health Examination Surveys of 6- to 11-year-olds from 1963 to 1965, and of 12- to 17-year-olds from 1966 to 1970, and the Health and Nutrition Examination Surveys I and II in 1971–74 and in 1976–80. These surveys have been useful primarily to the extent that they have provided the distribution of anthropomorphic and biochemical measurements in the population as a whole and, therefore, have contributed to knowledge about normal variation. Relatively few health problems that can be detected by examination of children occur frequently enough to provide stable estimates in sample surveys. Those few consist primarily of hearing and vision problems, iron deficiency, elevated levels of lead in the blood, and individual measures of psychological and cognitive functioning. Table 4 indicates the character of the data and the frequencies of abnormalities in the population. Children with a history of a variety of conditions are more likely than other children to be found on examination to have significant abnormalities [41]. However, a large proportion of children with a history of abnormalities have normal examinations and, conversely, a substantial proportion of children with no history of specific conditions have abnormalities of one sort or another on examination. Most of these data are 15 to 20 years old, but they are the most recent available.

The cumulative burden of health conditions as detected on exami-

Table 4: Children Found To Have Abnormalities on Examination*

Abnormality	Children (%)				
	Ages 1-5 (a)	Ages 6-11 (b)		Ages 12-17 (c)	
1. Physician finding a "significant abnormality"	NA	11.2	(1963-65)	21.8	(1966-70)
2. Otitis media	NA	1.6		1.8	
3. Cardiovascular	NA	2.6		4.6	
4. Injury, residual	NA	1.5		NA	
5. Neuromuscular or joint	NA	3.6		7.5	
6. Musculoskeletal	NA	NA		7.2	
7. Neurological	NA	NA		1.7	
8. Other congenital	NA	2.6		NA	
9. Other	NA	3.2		12.4	
10. Neuromuscular or joint (without accident)	NA	(3.3)		NA	
11. Other (without mention of congenital)	NA	(2.9)		NA	
12. Wearing corrective lenses	NA	11.8		30.1	(1971-72)
13. Failure to reach 20/20 vision with usual correction	NA	5.2		4.9	
14. Eye pathology (other than just vision disease)	0.1	0.2		0.2	
15. Nystagmus	0.3 (ages 1-3)	NA		NA	
16. Abnormality of auditory canal		21.0		16.0	(1966-70)
17. Abnormality of tympanic membrane		20.0		15.0	
18. Hearing difficulty†		0.8		1.3	(1971-74)
19. Needing dental care	16.6	63.5		53.6	
20. One or more decayed teeth	16.1	52.7			
21. Average number of decayed, missing, or filled teeth‡	0.1	1.7		6.2	(1971-74)
22. Gingivitis or more serious periodontal disease‡	NA	0.11		0.32	
23. Significant skin pathology	14.2	17.4		36.2	
24. Acne	—	(1.2)		(23.2)	

*Unless noted, information was derived or calculated from National Center for Health Statistics, Series 11, No. 129:

Items 12 and 13: Series 11, No. 206, p. 90.
Item 14: Series 11, No. 228, p. 21.
Item 15: Series 11, No. 206, p. 39.
Items 16(b) and 17(b): Series 11, No. 114, p. 5.
Item 18(b): Series 11, No. 102, p. 12.
Item 18(c): Series 11, No. 145, p. 20.
Items 19-22: Series 11, No. 214, pp. 7, 9, 14.
Items 23-24: Series 11, No. 212, p. 29.

†Mean threshold of 15 decibels or higher of frequencies 500-2,000 hertz.

‡No pathology = 1; mild gingivitis = 2; gingivitis = 3; pocket formation = 6; advanced destruction = 8. Score is arithmetic average of all teeth.

nation is provided by data from preinduction examinations of U.S. Army draftees. Although such draftees may not be representative of the entire population of young men in the United States, the data provide at least a rough estimate of the extent of health problems in late adolescence or early adulthood. Overall, only 53 percent of male youths were found acceptable: 36 percent were medically disqualified, 3 percent were medically and mentally disqualified, and 7 percent were mentally disqualified. The remaining 1 percent were disqualified for administrative reasons [11, Table 66]. The specific medical defects responsible for rejection and their frequency are as follows: musculoskeletal, 82; circulatory, 58; overweight, 46; mental disorder, 32; ear problems, 25; skin problems, 20; eye problems, 18; underweight, 13; drug abuse, 8; other, 70 [42].

INFORMATION FROM PHYSICIANS' OFFICES

The National Ambulatory Medical Care Survey provides information on the problems brought to physicians in office-based practice and the diagnoses made by them. The data are not representative of the population of children, because only 63 percent of all contacts with a physician (76 percent excluding telephone contacts) are in a physician's office [11, Table 75]. Moreover, approximately 7 percent of children received all of their care from a physician in an institution (hospital or freestanding clinic) in 1974 (more recent data are not available) [11, Table 79]. Nevertheless, these data provide the view of morbidity that is seen by the vast majority of pediatricians in the United States. The 54 most frequent problems, complaints, or symptoms presenting to physicians in 1975 by children and youth (from birth to age 21) account for 82 percent of all visits [43]. Table 5 presents the problems accounting for approximately two-thirds of all visits in the age groups 0–2, 2–5, 6–14, and 15–21. The number of office visits per 1,000 persons per year were 4,300 at age 0–2, 2,100 at age 2–5, 1,400 at age 6–14, and 2,100 at age 15–21.

The contribution that HMOs can make to information about child health needs was demonstrated by a study of the Columbia Medical Plan, a prepaid health plan in Columbia, Maryland [44]. Although the enrollees of this plan are primarily white-collar and middle-class, and hence are not representative of the entire population, the data have the advantage of providing information about the long-term health needs of individuals in a community.

Because of the prepayment mechanism and the relative ease of access to services, individuals are likely to receive all or almost all of

Table 5: Number, Percent Distribution, and Cumulative Percent of Office Visits Made by Children and Young Adults, by the 54 most Common Physician Diagnoses: United States, 1975*

Principal Diagnosis	*ICDA Code*	*Number of Visits (1,000s)*	*Distribution of Visits (%)*	*Cumulative (%)*
1. Medical or special examination	Y00	23,457	14.9	14.9
2. Acute upper respiratory infection	465	8,220	5.2	20.1
3. Otitis media	381	7,597	4.8	24.9
4. Prenatal care	Y06	6,050	3.8	28.7
5. Medical and surgical aftercare	Y10	5,867	3.7	32.4
6. Acute pharyngitis	462	4,597	2.9	35.3
7. Acute tonsillitis	463	4,543	2.9	38.2
8. Other eczema and dermatitis	692	4,158	2.6	40.8
9. Bronchitis, unqualified	490	3,280	2.1	42.9
10. Hay fever	507	2,968	1.9	44.8
11. Diseases of sebaceous glands	706	2,894	1.8	46.6
12. Other viral diseases	079	2,620	1.7	48.3
13. Inoculation and vaccination	Y02	2,611	1.7	50.0
14. Refractive errors	370	2,459	1.6	51.6
15. Observation, without need for further medical care	793	2,022	1.3	52.9
16. Asthma	493	1,753	1.1	54.0
17. Streptococcal sore throat and scarlet fever	034	1,706	1.1	55.1
18. Diarrheal disease	009	1,494	0.9	56.0
19. Influenza, unqualified	470	1,411	0.9	56.9
20. Cystitis	595	1,187	0.8	57.7
21. Neuroses	300	1,184	0.8	58.5
22. Otitis externa	380	1,127	0.7	59.2
23. Hypertrophy of tonsils and adenoids	500	1,089	0.7	59.9
24. Obesity	277	1,028	0.7	60.6
25. Acute nasopharyngitis (common cold)	460	1,015	0.6	61.2
26. Chronic sinusitis	503	985	0.6	61.8
27. Disorders of menstruation	626	985	0.6	62.4

28. Other and unspecified laceration of head	873	975	0.6	63.0
29. Acute bronchitis and bronchiolitis	466	973	0.6	63.6
30. Other ill-defined and unknown causes of morbidity and mortality	796	912	0.6	64.2
31. Other diseases of ear and mastoid process	387	883	0.6	64.8
32. Other person without complaint or illness	Y09	871	0.6	65.4
33. Pneumonia, unspecified	486	870	0.6	66.0
34. Acute laryngitis and tracheitis	464	804	0.5	66.5
35. Infective diseases of uterus (except cervix), vagina, and vulva	622	795	0.5	67.0
36. Postpartum observation	Y07	794	0.5	67.5
37. Conjunctivitis and ophthalmia	360	788	0.5	68.0
38. Impetigo	684	657	0.4	68.4
39. Sprains and strains of other and unspecified parts of back	847	625	0.4	68.8
40. Synovitis, bursitis, and tenosynovitis	731	623	0.4	69.2
41. Symptoms referable to abdomen and lower gastrointestinal tract	785	622	0.4	69.6
42. Other diseases of urinary tract	599	611	0.4	70.0
43. Other diseases of upper respiratory tract	508	593	0.4	70.4
44. Special symptoms not elsewhere classified	306	587	0.4	70.8
45. Other general symptoms	788	587	0.4	71.2
46. Infectious mononucleosis	075	582	0.4	71.6
47. Sprains and strains of ankle and foot	845	581	0.4	72.0
48. Chronic pharyngitis and nasopharyngitis	502	566	0.4	72.4
49. Transient situational disturbances	307	545	0.3	72.7
50. Behavior disorders of childhood	308	545	0.3	73.0
51. Strabismus	373	522	0.3	73.3
52. Gastritis and duodenitis	535	519	0.3	73.6
53. Other deformities	738	514	0.3	73.9
54. Symptoms referable to respiratory system	783	502	0.3	74.2
55. All other		40,678	25.8	100.0
All visits		157,431	100.0	100.0

*Based on *Eighth Revision International Classification of Diseases, Adapted for Use in the United States, 1965* (ICDA).
Source: National Center for Health Statistics. Vital and Health Statistics, Series 13, No. 39 [50].

their services in the plan; thus, a more thorough view of the health of individuals (rather than a view of the frequency of diagnoses) can be obtained. In this study, morbidity was classified into 14 types; each child was designated as having or not having each type in each of the three successive two-year periods. Although the frequency of specific illnesses varied with age, the frequency of each of the categories remained relatively constant with age [44].

Children with more frequent minor medical illness were much more likely to have diagnoses of other specific types than children with less frequent minor medical illness; conversely, children with any of the other types of diagnoses were much more likely to have minor medical illness than were children without the other types of diagnosis [44]. These findings indicate that illnesses tend to cluster in the population rather than being randomly distributed. Therefore, an understanding of child health needs requires techniques that permit researchers to categorize the health of individuals rather than count specific diagnoses.

The limitation of data collected in physician practices is that medical diagnoses may not accurately reflect the full spectrum of child health problems. Evidence of this is provided by a study of the prevalence of psychosocial problems in five different facilities serving children. The proportion of children seen in a year who had a diagnosis of a psychosocial problem varied from 5 to 15 percent in the primary care services of these facilities. In contrast, the variability in the proportion of children with a psychosomatic diagnosis was much less. As psychosomatic diagnoses are all associated with a somatic symptom, whereas psychosocial diagnoses have no associated somatic symptoms, it is apparent that at least some physicians are less likely than others to recognize problems that have no organic component.

We have reached several conclusions regarding morbidity in childhood:

- The burden of illness in childhood is difficult to specify, because the concept of illness defies definition and the manifestations of ill health vary with the method of collecting data.
- Collection of data on the prevalence of specific conditions or types of conditions fails to capture the nature of morbidity in children: some children tend to have many types of illness, and some have very few types.
- In childhood, injuries are the second most frequent category of health problems, after acute minor medical illnesses.

- Although most common health problems vary with the age of the child, there is at least some evidence to suggest that children with some types of health problems are at greater risk of subsequent health problems than are other children (further evidence for this is presented later).
- The most recent data on many aspects of child health status are a decade old. Although in many cases more recent data have been collected, they have not yet been analyzed.

RISK FACTORS IN CHILDHOOD DISEASES

Two premises guide us in our discussion of risk factors in childhood illness.

1. Disease (or illness) is rarely unifactorial in origin. There are almost always multiple factors to account for the occurrence of disease.

2. It is not always possible to predict which individual children are at risk of disease (or illness). Therefore, services must provide continuous care over long periods of time to detect children with incipient disease or those who become subject to conditions that predispose them to disease.

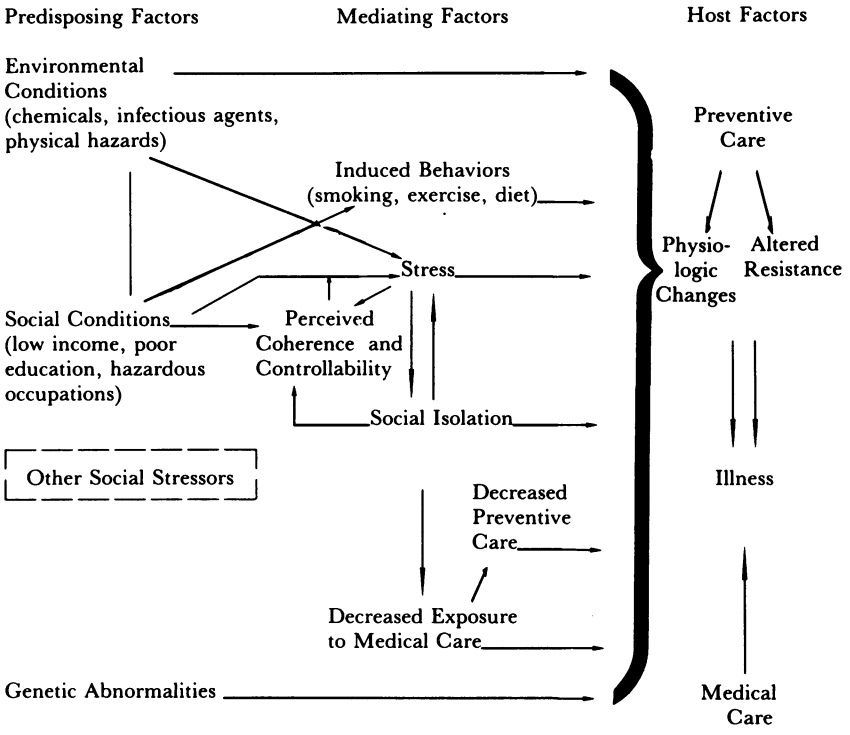
Figure 1 summarizes the types of factors involved in the pathogenesis of illness. Predisposing factors are environmental, social, and biological. Mediating factors are individual and group behavior, sociopsychological phenomena such as stress and social isolation, and inadequacies within the medical care system. Pathophysiological factors are the changes within the living organism that facilitate or inhibit the manifestations of disease when predisposing and mediating factors are present.

Prior or current illness appears to be an important determinant of both increased and decreased resistance to illness. States of illness may alter not only biological processes, but social conditions, behaviors, social isolation, stress, and exposure to medical care, also, so that vulnerability to subsequent illness is increased or decreased.

In this section, we summarize the relationships between the various types of factors—biological factors and genetic abnormalities, sociocultural factors, medical care, behaviors, and environmental factors—and the occurrence and severity of illness.

It should be clear at the outset that our discussions of risk factors in particular categories may erroneously imply artificial distinctions. Most of the time, one risk factor is associated with another and it is

Figure 1: Pathogenesis of Illness



Source: Starfield, B. Social Factors in Child Health [7].

generally not possible to separate them. Separating them into categories is done for convenience and for ease of conceptualization only. A more appropriate model of understanding risks and developing interventions might be that developed for understanding the cause of injuries (see further on, under "Environmental Risks"); although this model has not yet been used for other types of morbidity, it would appear to be at least potentially useful.

BIOLOGICAL RISK FACTORS

Health Problems as Risk Factors for Other Health Problems

Health problems are risk factors for other health problems in two ways: they tend to increase the likelihood of similar health problems later in life and to predispose to other health problems.

Starfield and Pless [1] used three types of evidence to determine the extent to which health problems persist through childhood. A review of the literature concerning the likelihood of persistence of 13 common illnesses indicated that, although knowledge about the natural history of common childhood disorders was sparse, there was evidence of considerable constancy over time, even for conditions generally considered to be acute or self-limited. The health problems included in that review were upper respiratory conditions, ear infections, asthma, hay fever, enuresis, obesity, hypertension, precursors of adult cardiac disease, urinary tract infection, neurosensory problems (including epilepsy), migraine, juvenile diabetes, and certain behavioral traits.

Studies of patterns of use of health services also show a tendency toward persistence of high utilization, a fact that suggests an underlying tendency for morbidity to persist. A review of evidence on general measures of health also showed relative constancy over time. In a longitudinal study dating back to the early 1930s in Boston, children with high scores for frequency of illness or for severity of illness early in life tended to have high scores later in childhood. Studies of Selective Service examinations showed that children with medical conditions noted on their junior and high school records were more likely to fail the examination, even when their defects in childhood were not of sufficient seriousness to mark them as likely to be so impaired. Conditions associated with higher rates of failure were uncorrected vision problems, a cardiac condition, asthma, a major accidental injury, placement in a special class for health problems, a behavior problem, or frequent absence. Conditions not associated with higher rejection rates were eye disease without visual defect, hearing loss or chronic otitis, underweight, mild orthopedic defect, hernia, a history of the common infectious diseases, chronic tonsillitis, and low birth weight [1].

Children who had abnormalities when examined at ages 6 to 11 in the 1963–1965 HES were more likely than other children to have abnormalities when examined at ages 12 to 17 in the 1966–1970 survey. This was true of children who took medicines regularly, those who had hearing problems or walking problems, those with initially restricted activity, and those with frequent school absences [1].

Data from the British Birth Cohort studies also show that children with problems early in life (such as respiratory problems or hospitalizations) are more likely to have them as teenagers than are other children [1].

In a study by Brunswick [33], black adolescents in Harlem were interviewed at ages 12 to 17 and again at ages 18 to 23. Although a considerable shift occurred in the morbidity of individual children, both relative and attributable risks for most of the reported conditions were significantly higher than could be accounted for by chance distributions of illness. That is, individuals who reported the presence of a problem early in adolescence were more likely to report that condition as present later in adolescence than were other children, and individuals who had a problem later in adolescence were more likely to have had it earlier than were individuals without the condition [45].

A recent study of morbidity over a 6-year period among children enrolled in a prepaid group practice showed evidence of clustering rather than random distribution. Children with greater burdens of minor medical morbidity (acute medical conditions) had a significantly greater likelihood of having other types of health conditions as well, including injuries; chronic medical problems; orthopedic, visual, hearing, or dermatological conditions; and psychosocial problems. Moreover, some conditions long thought to be relatively acute and self-limited, such as otitis media and psychosomatic symptoms, were found to persist in individual children to an extent greater than expected [44].

These data indicate that at least some illnesses tend to predispose children to other illnesses. The clustering of morbidity is not widely recognized, because most studies of the prevalence of illness provide information on the frequency of individual illnesses rather than on the proportion of children with various combinations of illnesses. Moreover, there is little, if any, research on the genesis of such clustering. Such research will have to include consideration of social as well as biological phenomena, because there is increasing evidence of the impact of social and environmental factors on child health.

Race

Low birth weight. Low birth weight (2,500 grams or less) occurs approximately twice as often among blacks as among whites [11, 12, 46]. From 1950 to the mid-1960s, the overall rate of low birth weight increased from 7.5 percent to 8.3 percent. The rate then declined to 7.1 percent in 1977 [12]. It is not clear whether this rise and fall was a true pattern or simply a reflection of better reporting for black births during

that period. Since "just about all of the increase was among non-white births" [12] increased reporting for blacks would have made the overall rate appear to have risen.

Other races are also at risk for babies with low birth weight: rates are highest among blacks, then Japanese-Americans, American Indians, whites, and Chinese-Americans [46].

Although race is clearly a risk factor for low birth weight, the balance between genetic and other factors remains unclear. The evidence strongly suggests that genetic predispositions, if any, are substantially influenced by environmental, sociocultural, behavioral, and medical care factors. For example, within a given race, the rate of low birth weight is higher for U.S.-born women than for foreign-born women. This is especially true for blacks and Chinese-Americans [46]. Rates within races are partially offset by higher maternal education levels. Although rates of low birth weight are higher for blacks, the pattern is somewhat different when gestational age is taken into account: for preterm babies, blacks weigh more than whites; at term, white babies outweigh black babies by about 200 grams. To at least one author, this suggests that "social disadvantage" retards the growth of black babies [46]. Similarly, the differences in rates of low birth weight among races are partially the result of adequate prenatal care, compared with inadequate or intermediate care [47].

Infant mortality. Black infant mortality is approximately twice white infant mortality [12]. This ratio held in all final vital statistics data for the period 1958 through 1980 (see Table 6). Before that time, the ratio was slightly less than 2 to 1, perhaps because the reporting of black infant deaths was less comprehensive then.

While infant mortality rates have been declining in both racial groups, the gap has persisted. The result is that blacks lag approximately 20 to 25 years behind whites in reaching major landmarks. That is, whites achieved an infant mortality rate below 40 per 1,000 live births in 1942; blacks did not reach that level until 1967. Similarly, whites fell below 30 per 1,000 live births in 1948, while blacks did not fall below that level until 1972. More recently, whites fell below 20 per 1,000 live births in 1967, but blacks have not yet reached that level. Moreover, white infant mortality is now approaching a figure of 10 per 1,000 live births, a level nowhere in sight for blacks.

The implication of these racial differences is extremely grave. If blacks had achieved rates equal to those of whites, approximately 6,000 fewer black babies would have died in 1979. Conversely, if white families had to endure the same rates that black families experience, nearly

Table 6: Infant Mortality Rates by Race: United States, 1940–83 (Rates are deaths under 1 year per 1,000 live births in specified group)*

	Infant Mortality Rate		
Year	*Total*	*White*	*Black*
1983†	10.9**		
1982†	11.2**	—	—
1981	11.9***	10.5	20.0
1980	12.6	11.0	21.4
1979‡	13.1	11.4	21.8
1978‡	13.8	12.0	23.1
1977‡	14.1	12.3	23.6
1976‡	15.2	13.3	25.5
1975‡	16.1	14.2	26.2
1974‡	16.7	14.8	26.8
1973‡	17.7	15.8	28.1
1972‡§	18.5	16.4	29.6
1971‡	19.1	17.1	30.3
1970‡	20.0	17.8	32.6
1969	20.9	18.4	34.8
1968	21.8	19.2	36.2
1967	22.4	19.7	37.5
1966	23.7	20.6	40.2
1965	24.7	21.5	41.7
1964	24.8	21.6	42.3
1963¶	25.2	22.2	42.8
1962¶	25.3	22.3	42.6
1961	25.3	22.4	41.8
1960	26.0	22.9	44.3
1959	26.4	23.2	44.8
1958	27.1	23.8	46.3
1957	26.3	23.3	44.2
1956	26.0	23.2	42.4
1955	26.4	23.6	43.1
1954	26.6	23.9	42.9
1953	27.8	25.0	44.5
1952	28.4	25.5	46.9
1951	28.4	25.8	44.3
1950	29.2	26.8	43.9
1949	31.3	28.9	46.8
1948	32.0	29.9	45.7
1947	32.2	30.1	47.7

Continued

Table 6 Continued

Year	Infant Mortality Rate		
	Total	*White*	*Black*
1946	33.8	31.8	48.8
1945	38.3	35.6	56.2
1944	39.8	36.9	59.3
1943	40.4	37.5	61.5
1942	40.4	37.3	64.2
1941	45.3	41.2	74.1
1940	47.0	43.2	72.9

*Source: Compiled by National Center for Health Statistics, Division of Vital Statistics from various years of vital and health statistics, except as noted by ** = Vol. 32, No. 13 [6]; and *** = Vol. 33, No. 3 [7].
†Provisional data.
‡Excludes deaths of nonresidents of the United States.
§Deaths based on a 50 percent sample.
¶Figures by color exclude data for residents of New Jersey.

30,000 more white babies would have died in 1979 than actually did. Similar figures could be expected for all recent years.

It is clear that the differences in infant mortality between blacks and whites result from the differences in birth weight, particularly the higher rate of low birth weight among blacks [48, 49]. Since mortality rates are much higher for very small, premature infants than for full-term, fully grown ones, a difference in rates of prematurity and low birthweight will have a substantial effect on overall mortality rates. When mortality rates within birth weight groups are analyzed, non-whites have better survival rates for birth weights of less than 1,500 grams, 1,501 through 2,000 grams, and 2,001 through 2,500 grams; whites have better survival rates for birth weights above 2,500 grams [49]. This relationship persists even when holding constant a variety of other factors [49]. Similarly, nonwhites were shown to have an 80 percent higher infant mortality rate even after holding constant per capita income (and measures of radiation, the principal independent variable in that study) [50].

Chinese-Americans not only have lower reported rates for low birth weight; they also report lower infant mortality rates. In 1978, Chinese-Americans had an infant mortality rate of 6.3 per 1,000 live births, compared with 12.0 per 1,000 for white Americans [51]. This difference may reflect a true biological discrepancy, but other factors

cannot be entirely ruled out, such as reporting differences and misclassification by race.

Child and young adult mortality. For children age 1 through 4, blacks have an approximately 50 percent higher mortality rate. More than half of this difference is due to higher rates for the leading causes of death: injuries and homicide. Blacks also have higher rates for heart disease but experience somewhat lower rates for malignant neoplasms [11].

For children and youths age 5 through 14, blacks also have higher overall rates, by about one-third. Again, this difference is due primarily to higher rates of injuries and homicide, with a minor contribution from heart disease, congenital anomalies, and malignant neoplasms [11].

Differences by race are also substantial in the 15 to 24 age group. Overall, the gap between white and all other death rates has narrowed substantially over the past 30 years. White males showed a rise that has only slowly begun to decline. All other males showed a tremendous rise between 1960 and 1970, nearly 50 percent. This has fallen dramatically since, but it remains above the level for white males. Death rates for females other than whites show the most consistent and substantial decline since 1960, even after a very large decline over the 1950s.

Morbidity other than low birth weight. Race is a risk factor for a variety of indicators of health status. The caution noted above needs to be repeated—differences by race do not necessarily mean that genetic differences by race exist. In this society, race is associated with higher social risk, particularly low income and low maternal education. Since most of the available studies are univariate or bivariate analyses, it is not possible to specify how much of the racial difference in morbidity is genetic and how much is secondary to sociocultural and other correlates of race; that will have to wait until multivariate analyses have been conducted.

Black children are more likely than white children to have a low parental perception of health status [11]. In the mid-1970s, blacks had increased rates of reporting only good, fair, or poor health status and decreased rates of reporting excellent, compared with whites. Analyses of data from the 1960s yielded similar findings [41, 52].

There has been no overall difference by race in reported limitation of activity due to chronic conditions [11]. Preliminary findings from a current analysis of NHIS data show that rates of limitation of activity by race in general have fluctuated irregularly over the past 23 years [53].

Cycle III of the HES reported that blacks age 12 through 17 had

significantly lower hematocrits than whites [54]. The discrepancy was worse among females. These differences were not diminished when socioeconomic status was taken into account, unlike the clear trend for whites. Although diseases such as sickle cell anemia are more prevalent among blacks than whites, it was felt that the observed differences were "unlikely to be due to higher rates of abnormal hemoglobin."

The first cycle of the National Health and Nutrition Examination Survey showed that low hemoglobin is associated with race even in multivariate logit analyses. However, missing data precluded separating children with low hemoglobin into those who were deficient in iron and those who had other causes of low hemoglobin. Within age groups, black females age 2 through 3 were more likely than whites to have low values for both iron status indicators (low hemoglobin and low transferrin saturation). Otherwise, racial differences were not prominent or statistically significant. Therefore, the nature of the relationship between race per se and anemia is still uncertain.

Cycle I of the National Health and Nutrition Examination Survey reported marked racial differences in visual abnormalities. Using as an indicator of visual performance the child's usual correction (that is to say, with glasses, if worn), blacks at all ages had a lower proportion of children with at least 20-20 vision in either eye. The results for preschool children (age 4 to 5) (13.2 percent for blacks, 33.9 percent for whites) and for children age 6 to 11 (55.7 percent for black, 75.4 percent for white) were significantly different. Using defective acuity (distance of 20-50 or worse in the better eye) with the usual correction in the better eye as the indicator, the rates were seven times higher for black than for white preschoolers (7.1 percent compared with 1.0 percent). For ages 6 to 11, whites had slightly higher rates of defective vision than blacks, but blacks had consistently higher rates at older ages.

These differences did not disappear when the study considered refraction potential (the ability to reach 20-20 with maximal correction, regardless of the usual correction worn). Blacks had lower rates (worse) for preschool and for ages 6 to 11. Blacks also had higher (worse) rates than whites in the proportion with no better than 20-50 vision for the preschool group. Comparison of usual correction with refraction potential shows that only a small percentage of blacks have a usual correction that is inadequate to attain their maximal possible correction. Thus, the racial differences in visual abnormalities are due not only to inadequate access to visual aids; they persist even when children are given maximal possible correction.

A separate analysis of age-adjusted prevalence rates of eye dis-

eases and of the need for treatment showed statistically significant differences, with blacks worse than whites, when examining rates from age 1 through 74. The results, however, were variable when age-sex groups were looked at by race. That is, for some age-sex groups whites were worse; for others blacks were worse.

The only substantial racial difference in hearing abnormality reported in Cycle III of the HES was that whites had slightly better hearing than blacks among youths age 12 through 17 in two of three pure tones needed for speech (1 kilohertz and 2 kilohertz).

The first National Health and Nutrition Examination Survey found no consistent pattern of differences between the races. Whites had higher rates for a history of mumps, chicken pox, scarlet fever, broken bones, asthma, hay fever, surgical operations, bronchitis, earaches, and otorrhea. Blacks had higher rates for pertussis, frequent colds, eye pathology, and speech problems [41].

In Cycles II and III of the HES, blacks had an increased proportion of children with "significantly abnormal" findings on examination. These differences were statistically significant for the age group 6 to 11, with 13.8 percent for blacks and 10.8 percent for whites. Differences were observed but were not statistically significant for the age group 12 to 17 [41]. Other researchers analyzing the same data found these differences, but in their analysis the differences were not statistically significant [52]; however, they used a subsample of the data that excluded 43 percent of the nonwhite children. This reduction in sample size undoubtedly influenced the statistical significance of the finding.

Multivariate analysis of the influence of race. Because race is so often an identifiable risk factor, many investigators have sought to determine the influence of race per se as opposed to race as a proxy for sociocultural and other factors. Edwards and Grossman [52] have conducted an extensive analysis and have concluded that race differentials may increase when socioeconomic variables are held constant, but with no favoring of either race. Because of the potential importance of this conclusion, it warrants further analysis.

Analyzing by race alone, Edwards and Grossman found both differences that were statistically significant and differences that were not. Differences that were statistically significant showed blacks worse on parental assessment of health status and whites worse on height, history of allergies, and parental assessment of tension level. Differences that were not statistically significant showed blacks worse on diastolic blood pressure above the 95th percentile for age and sex and on the proportion with significant abnormality detected on physical examination; whites were worse on uncorrected binocular distance

vision, periodontal index, and excessive absence from school for health reasons.

In their multivariate analysis they held constant family income, parents' education, the presence of a father in the home, whether the child was a twin or first-born, whether a foreign language was spoken in the home, region of the country, residence in metropolitan or non-metropolitan area, and child's sex. When these factors were taken into account, blacks were less healthy with regard to two measures: history of allergies and physician examination reporting significant abnormalities. Whites were less healthy according to parental assessment of health status (a change from the univariate analysis), height, tension level, and periodontal index. These findings led Edwards and Grossman to the conclusion noted above, that holding socioeconomic variables constant may increase racial differentials but with neither race being favored and sometimes even with the racial differences being reversed [52].

These conclusions, however, may not be generalizable, at least in part because of the nature of the indicators used in the analyses. Height, for example, is a questionable measure of health status, and the periodontal index has not been used in later work by the National Center for Health Statistics for children because it does not provide useful comparisons under age 18 [55, 56]. Does a history of allergies and a physician's report of serious abnormalities outweigh parental assessment of health status and tension level? Without knowing how well these measures correlate with functional impairment or other indicators of poor health status, it is not possible to consider the conclusion drawn by Edwards and Grossman as anything more than an interesting and provocative assessment.

Genetic and Possibly Genetic Factors

Discussions of genetic factors often focus on congenital malformations and other birth defects. These abnormalities include a wide range of structural, functional, and metabolic abnormalities that are determined to be present, if not recognizable in all cases, at birth. But only some one-fourth to one-third of birth defects in newborns can be attributed to clearly genetic etiologies; the remainder are either nongenetic in origin or are multifactorial disorders [52]. Multifactorial entities are those that appear to have a genetic component but do not follow strict laws of inheritance and often are influenced by environmental or even unknown factors. Thus, in considering the risks attributable to genetic disorders, it is important to recognize that for many conditions the

precise contribution of genetic, environmental, and unknown factors is not clear.

Mortality. Infant mortality rates due to congenital malformations have decreased over time but less rapidly than overall infant mortality rates. Thus, the relative contribution of congenital malformations to total infant mortality has increased substantially. In 1915, deaths due to congenital malformations accounted for 6.4 percent of infant mortality, which then was about 100 per 1,000 live births. By 1976, deaths due to congenital malformations accounted for 17.3 percent of infant mortality, which by then had fallen to only 15 deaths per 1,000 live births. Thus, even though the mortality rate due to congenital malformations fell from 6.4 per 1,000 live births to 2.6 per 1,000 live births, the proportion due to congenital malformations increased nearly threefold [58]. When certain disorders, such as single-gene disorders (for example, cystic fibrosis) and some chromosomal abnormalities that are not generally included in congenital malformations, are added in, genetic disorders account for 20 percent or more of infant deaths.

Even in more recent years, the decline in overall infant mortality has outpaced the decline in congenital malformations. Between 1968 and 1975, total infant mortality fell from 21.8 per 1,000 live births to 16.1, a decline of 26.3 percent. During that same period, infant mortality due to congenital malformations fell from 3.2 per 1,000 live births to 2.7, a decline of only 13.5 percent [59].

In the age group 1 to 4, congenital malformations are the second leading cause of death [58]. Thus, they account for 17 percent of deaths in that age group [59]. For ages 15 to 19, congenital malformations are the third leading cause of death [58].

Approximately 50 to 60 percent of spontaneous abortions in the first trimester are associated with chromosomal abnormalities [58]. For example, about two-thirds of Down's syndrome conceptuses abort spontaneously, as do 95 percent of conceptuses with trisomy 13 or 18, or with 45 X0 Turner's syndrome.

In sum, genetic factors can place the child at risk for death during infancy or childhood. Because diseases that are genetic or substantially genetic in origin have not declined at the same rate as other diseases, their contribution to infant mortality is increasing somewhat, even though their absolute values have declined.

Genetic factors also play a significant role in diseases that may not appear until early in adulthood or even later. In particular, coronary heart disease has a clearly genetic component, although the precise genetic influence is not yet determined [60, 61]. The genetic aspects of coronary heart disease are manifested by evidence such as sex differ-

ences; variability in risk factors such as lipid and lipoprotein levels, hypertension, diabetes, and multiple unidentified factors; the genetic basis of childhood disorders involving coronary disease; and anatomical variations and ethnic differences [60]. Although coronary disease has a strong genetic component, many authors are optimistic that early identification and interventions might ameliorate the progress of the disease [61, 62].

Morbidity. Genetic factors place children at risk of a variety of health disorders. Severe mental retardation is, of course, one of the conditions that is known to have a strong genetic association.

> It has been estimated that at least 40% of all individuals with an I.Q. less than 50 in the United States have a chromosomal disorder (primarily Down's syndrome), single gene disease (e.g. Huntington's disease, X-linked mental retardation, Tay-Sachs disease), or a severe developmental malformation syndrome (neural tube defect, hydrocephalus) [58].

Many of these conditions are not simply genetic disorders per se but are "disorders strongly influenced by genetic factors" [58].

Looking beyond just chromosomal anomalies, one can see the influence of genetic factors on severe mental retardation (IQ below 50). In developed countries the estimated contribution of genetic factors to severe mental retardation includes chromosomal abnormalities (36 percent), congenital malformation syndrome with recurrence risks (27 percent), and genetic metabolic errors (8 percent). Thus, diseases with a definite genetic origin or that are influenced significantly by genetic factors together account for over 70 percent of severe mental retardation in developed countries [58]. Other causes include prenatal factors (8 percent), perinatal factors (9 percent), and infections (12 percent). As a measure of severity, genetic factors are estimated to account for 20 to 25 percent of the institutionalized mentally retarded in the United States in 1970 [58].

Other indicators of health status are also affected by genetic factors, particularly the need for specialized services and intensive medical care. Among children age 1 day to 18 years, 25 to 30 percent of hospital admissions are "for conditions of definite genetic origin . . . or disorders strongly influenced by genetic factors . . . " [58]. Low birth weight is often a family tendency as well [13].

The risk for genetic disorders is not high for any individual condition but the cumulative risk is significant. Chromosomal abnormalities are estimated to occur in 5.6 per 1,000 newborns and in 22 per 1,000 full-term infants with low birth weights [58]. Most fetuses with major chromosomal abnormalities do not survive pregnancy. Of the ones who

do, some have normal or only minimally abnormal clinical phenotypes. Most of the recognized syndromes in infancy or childhood are associated with mental retardation and/or obvious physical malformations [58]. The frequency of single-gene disorders has been estimated to be 10 to 20 per 1,000 live births, but many of these are of little consequence. Multifactorial disorders occur in 10 to 20 of each 1,000 live births. These include interactions of multiple genes or the environment or both. This group includes most of the major birth defects and malformation syndromes, such as club foot and cleft palate.

Medical Complications of Pregnancy Through Delivery

Mortality. A number of medical complications put the fetus at risk of death during the perinatal period. An analysis of British data from 1971 shows that complications of pregnancy were by far the most important cause of perinatal mortality. Among the complications of pregnancy, intrapartum events accounted for 29.1 percent, antepartum events for 13.8 percent, and maternal disorders for 14.5 percent (including toxemias, 5.8 percent, and hemolytic disorders, 3.0 percent). The other causes of perinatal mortality include congenital malformations (19.7 percent) and prematurity (20.2 percent) [58].

Maternal diabetes mellitus creates a high risk of perinatal death. Untreated diabetes mellitus is "incompatible with successful outcome of pregnancy"[9]. It is possible now to attain perinatal mortality rates of approximately 40 per 1,000 among mothers with diabetes mellitus. Some have even argued that "perinatal survival has become as common in these pregnancies as in normal ones" [63].

Elective termination of pregnancy is increasingly used between 35 to 38 weeks of gestation to avoid the increased risk of *in utero* fetal death [63]. This has increased the mortality rate from respiratory distress syndrome (RDS) among infants of diabetic mothers. With improvements in treatment of RDS, congenital malformations are now the most common cause of death among infants of diabetic mothers, whereas RDS had previously been the most common [63, 59].

Hypertensive disorders are found in 6 to 8 percent of pregnant women. Perinatal mortality rates of infants with hypertensive mothers have been reported to be between 4 and 48 percent [9], much higher than in the general population of infants. Clearly, hypertensive disorders create a high risk of fetal death.

Early studies identified prior fetal loss as a risk factor for subsequent perinatal mortality [64]. This conclusion has been challenged because no control for birth weight, maternal age, or socioeconomic

status was possible [13]. Later work in a multivariate analysis found an effect of prior fetal loss that depends on birth order [49, p. 84]. For second and third births, prior fetal loss is associated with an increased risk of neonatal mortality, in a ratio of 1.21 to 1 (relative to second births with no prior fetal death).

Morbidity. Diabetes mellitus is known to be one of the factors that affects birth weight [13], by increasing birth weight for a given gestational age. Diabetes is associated with an increased risk of congenital anomalies, especially the caudal regression syndrome [59]. It is also associated with other congenital anomalies, with macrosomia, and with RDS [9]. The infant is also at increased risk for hypoglycemia, hypocalcemia, hyperbilirubinemia, cardiomyopathy, polycythemia and hyperviscosity, and the small left colon syndrome. Thus, although mortality rates for infants of mothers with diabetes mellitus have declined substantially, the risk of serious disorders in the newborn persists.

A well-known group of infectious diseases in the mother place the infant at risk: toxoplasmosis, rubella, cytomegalovirus, herpes, and other, similar maternal infections during pregnancy (the TORCH syndrome). These infections are associated with 1 to 5 percent of fetal malformations and with a "significant portion" of deafness and mental retardation [9]. Bacteriuria is also associated with low birth weight and thus with increased risk of perinatal mortality [9].

The administration of medications to pregnant women increases the risk of a variety of disorders in the newborn. These include masculinization disorders from progestins; fetal hemorrhage and altered bone development from anticoagulants; behavioral changes from tranquilizers; adenocarcinoma and altered uterine morphology from diethylstilbestrol (DES); and teratogenic changes from thalidomide and diphenylhydantoin [9]. This latter entity, the fetal phenytoin (hydantoin) syndrome, includes a particular pattern of growth deficiency, craniofacial abnormalities, various degrees of intellectual impairment, and an increased risk of other major malformations [59].

An estimated 1 to 5 percent of congenital defects are caused by drugs [59]. There is a high level of risk for these complications of therapy, depending upon how often drugs are administered during pregnancy. Three separate studies of the mean number of drugs per pregnancy show an increase from 4.0 in 1967, to 8.7 in 1970 and 10.3 in 1973 [59].

Intrapartum events can produce hypoxic damage to several organ systems—respiratory, renal, central nervous, and gastrointestinal. The

two most common complications are cerebral palsy and mental retardation.

Cerebral palsy is now reported in about 2.0 to 2.5 per 1,000 school-age children [58]. Cerebral palsy is well known to be associated with hypoxic damage, although the relationship is not as clear-cut for mental retardation. A review of the literature concluded that the association between perinatal events and cerebral palsy is much stronger than is the case for mental retardation [58]. Intrapartum events constitute a serious risk factor for cerebral palsy, since it has been estimated that approximately 20 to 40 percent of cerebral palsy is due to such hypoxic insults [58].

Although the relationship for mental retardation is not as clear as for cerebral palsy, it is estimated that about 10 percent of severe mental retardation is associated with perinatal events [58]. "Biologic insult" is more often associated with severe mental retardation, whereas a combination of environmental deprivation and insufficiency of postnatal stimulation [58] are associated with the more common milder mental retardation.

Mother's Age

The mother's age is associated with increased risks for both mortality and morbidity in the infant. In a multivariate analysis, mothers over 34 years of age were found to have a ratio for neonatal mortality of 1.07 to 1, when compared with mothers age 18 through 34 [49]. The relationship between maternal age and infant mortality is nonlinear. The optimum childbearing age is 25 through 29, with higher risks earlier and later [13].

Maternal age interacts with birth order to reduce birth weight [13]. Younger women (under age 24) have lighter babies with increasing birth order. The opposite, however, is true for women over 30. Thus, maternal age is a risk factor for low birth weight, but the risks are different for different birth order, depending upon the mother's age.

Child's Sex

Boys have higher death rates in all age groups throughout infancy and childhood [13]. The ratio of male to female mortality rates varies widely, however, from infancy to young adulthood. Data for 1981 show ratios for male to female mortality rates as follows: infancy, 1.31 to 1; ages 1 through 4, 1.32 to 1; ages 5 through 14, 1.72 to 1; and ages 15 through 24, 2.88 to 1. Thus, being male is a risk factor for mortality,

one that increases with age throughout young adulthood. The differences in death rates for adolescents and young adults are particularly striking, since the rates for girls are approximately one-third of those for boys. Moreover, while death rates for girls did rise slightly between 1960 and 1970, they have declined steadily since then and are now below the earlier rates. The death rates for young men, however, rose much higher and still have not fallen below earlier levels; thus, males account entirely for the recent level trend in this age group.

Morbidity differences by sex also exist. Preliminary analyses of limitations of activity due to chronic conditions as reported in the NHIS [53] show that boys have higher rates than girls and have had a more rapid rate of increase over the past 20 years.

SOCIOCULTURAL RISK FACTORS

Income

A powerful correlate of ill health in childhood is family income. Illness is more common among poor children and, even more strikingly, it is more severe when it occurs [65]. Clinical and epidemiological studies indicate that poor children are twice as likely to have low birth weights, twice as likely to contract illnesses such as bacterial meningitis, three to four times as likely to lack indicated immunizations in the preschool period, two to three times as likely to contract illnesses such as rheumatic fever, two to three times as likely to have iron-deficiency anemia, two to three times as likely to have hearing problems, 50 percent more likely to have uncorrected vision difficulties (although they are less likely to have visual problems when testing is performed without the child's usual correction), nine times as likely to have elevated concentrations of lead in their blood, and 75 percent more likely to be admitted to a hospital in a given year.

Poor children have 30 percent more days when their activity is restricted and 40 percent more days lost from school due to illness. They are more likely to be reported by their parents as having one or more chronic conditions. Three to six times the proportion of poor children are reported by their teachers as being in fair or poor health, and the same teachers report that three times as many poor children have a condition that limits schoolwork or play [22]. Poor children are also more likely to be diagnosed by physicians as having one or more psychosocial conditions [35] and are 40 to 50 percent more likely to be found to have a significant abnormality on physical examination by a physician. Family income is more strongly related to these measures of

ill health than are other sociodemographic characteristics, such as race and parental education [20].

Mortality rates of poor children are much higher than the rates for nonpoor children. Neonatal mortality rates are 1.5 times higher among poor children, and postneonatal mortality rates are twice as high. Poor children are approximately 1.5 to 3 times as likely to die after the first year of life as nonpoor children (data estimated from [66, 67]). The higher death rates among the poor are not due to a higher proportion of nonwhites among the poor, as the discrepancies across income groups are even more consistent and striking within the white population alone [66]. Poor children are more likely to die from injuries [66] and from conditions such as leukemia [68]. Perinatal problems, when they occur, have greater impact and more sequelae in poor children [69, 70, 71], and poor children have greater deficits in IQ when born at low birth weight than do other children [72]. Twice the proportion of poor children have marked iron deficiency, and poor children are much more likely to have markedly elevated blood lead levels. Poor children with appendicitis are more likely to experience appendiceal perforation and peritonitis than are nonpoor children [73]. Poor children are two to three times as likely to have severely impaired functional vision (20-50 or worse with usual correction).

The average length of stay in the hospital is twice as long for poor children, and their average total hospital days are four times as high as for other children. Common conditions, such as asthma, tend to be more severe in poor children. More frequent and longer hospitalization is also experienced by poor children with uncommon conditions. For example, for diabetes, the rate of hospitalization is at least two to three times greater for poor than for nonpoor children. Poor children are 20 times more likely than nonpoor children to be unable to attend regular school because of a health-related problem and are twice as likely to be limited in their ability when they do so. Although evidence on the relative prognosis of health problems in poor and nonpoor children is scant, the data that do exist suggest that the illnesses of poor children are more likely to persist or have sequelae [1].

Thus, there is compelling evidence that low income and poverty are important risk factors for childhood illness. Documentation of the mechanisms by which poverty exerts its effects is lacking, but inferences can be drawn from research on a variety of factors [7]. Poor children are more likely to be exposed to environmental toxins because of the neighborhoods in which they live. Greater life stresses among poor families also predispose to greater illness. To the extent that medical care can prevent or ameliorate illness, barriers in access to appro-

priate and timely care are also associated with more frequent and more severe illness [31, 74].

Parental Education

Differences in family income are often associated with other sociodemographic differences, some of which may have important independent effects on health status. Because the implications for health policy may differ depending upon the relative impact of various risk factors, it is necessary to consider these effects.

Edwards and Grossman, in their analysis of data from the HES in the early 1960s, show how the effects of income differences on certain aspects of child health are reduced or eliminated when other sociodemographic factors are controlled [52]. These data, which were collected previous to the improvements in access to medical care that resulted from the legislation of the mid-1960s, indicate that one measure of health—allergies, as reported to be present in children by a parent—was more common among upper-income children; two measures—reported poor health and poor dentition, as determined by professional examination—were more common among poor children. When the analysis was controlled for several other sociodemographic characteristics (parental education, father living with the family, whether the child is a twin or first-born, foreign language spoken in the home, region and size of city of residence, and sex), the differences between income groups disappeared. Therefore, it is apparent that factors such as parents' level of education may at least modify the relationship between income and ill health. Mechanisms by which this may occur include the following:

- Increased reporting of problems by more highly educated parents because of their increased awareness
- Increased reporting by more highly educated parents who may have better access to medical care, leading, therefore, to better or more comprehensive diagnosis
- Better health among offspring of more highly educated parents as a result of earlier care or more appropriate care, perhaps especially preventive care.

Support for these hypotheses is provided by several studies.

At a time when access to and financing of medical care was much more limited for poor families, parental education would be expected to have been an especially salient determinant of care seeking. Therefore, controlling for the effect of education (as well as other related

factors) could reduce or eliminate the effect of income on some measures of health. Reported allergies are particularly indicative of a child's having received medical care, because symptoms of allergies may be attributed to something else in the absence of specific diagnostic tests. Significant dental problems, before fluoridation of water was widespread, were preventable with access to and receipt of dental care. These and parental reports of the child's being in poor health would be expected to indicate the prior receipt of medical care.

Subsequent data provide additional insights. Data collected as part of the 1976 National Survey of Child Health [22] show that the disparity between reported fair or poor health was greater among the less well educated as compared with the better educated than it was among the poor as compared with the nonpoor. However, other measures of ill health were more susceptible to the effects of income than to the effects of education. These included teacher assessments of poor or fair health and the proportion of children with 2 or more days' absence from school per year. The disparity in limitation of activity due to health problems was equal to or greater for income than for education. In contrast, a measure of the utilization of preventive services—the percentage of children who had not seen a dentist in 2 years—showed much greater effects of education than of income. For measures of health that are more directly related to education (vocabulary, school performance, practical skills, misbehavior according to the child, the child's feeling of rejection, and the child's level of fears and worries), parental education ranked higher as an associated variable than did family income [11]. Data from the NHIS in 1975–1976 show similar patterns of relationships. Parental assessment of health [11, Table 51] and the likelihood that the most recent visit to a doctor was for a general checkup [11, Table 76] were more sensitive to the effect of parental education than to the effect of income, whereas the effect of income was much greater than the effect of education in the case of limitation of activity of all types associated with chronic illness [11, Table 53] and disability days of all types associated with acute illness [11, Table 54].

These findings indicate that the methods used to measure health have a large impact on findings regarding the relative importance of various sociodemographic factors, such as income and parental education. Subjective measures that require parental judgments are likely to show a greater effect of education, particularly when access to medical care is likely to have been less or different. Greater effects of education are also likely when the measure reflects the seeking and receipt of preventive care. More objective measures of health, particularly those

that are not as readily preventable by medical care, appear to be more influenced by income.

Family Structure

Family structure and disorganization have been the subjects of some recent research. Studies have noted an increased risk of physical injury for children whose lives are characterized by social disruption, single-parent families, loose parental supervision, and family stress [75].

Of great concern is the relationship between family structure and adolescent suicide. One extensive review of the literature concluded that "family conflict has repeatedly and consistently been identified in the background of suicidal adolescents and as a leading precipitant to their suicidal behavior; it may be particularly the nature rather than extent of such conflict that is significant" [76]. Additional family factors associated with adolescent suicide include the role of the mother in the family; estrangement of adolescent girls from parents; the child's age at loss of a parent; relative social isolation; increased geographic mobility; and, possibly, the role of another suicide in the family. Some of the school, family, social, and psychological problems may be common to disturbed adolescents and not specific to suicidal behavior; understanding the relationships among multiple factors over time is necessary in any efforts to predict and prevent suicide.

MEDICAL CARE AS A MODIFIER OF RISK FOR ILLNESS

Disparities in Receipt of Medical Care

Table 7 shows that the poorer the family, the more likely the children are to have no regular source of care and to have a place rather than a particular physician as their regular source of care. Conversely, they are much less likely to have a specialist in child health as their regular source of care.

Table 8 shows that insurance has a large impact on whether or not the child has a regular source of care, even when the family has a low income. Almost twice the proportion of poor children (income 150 percent or less of the poverty level) who are uninsured lack a regular source of care as compared with those on Medicaid and those with private or military insurance. Even with insurance, however, poor children with Medicaid and those who are uninsured are more likely to have a place without a particular physician as their regular source of care (37.5 and 38.9 percent, respectively) than are poor children with

Table 7: Regular Source of Care for Children and Youth Under 18 Years of Age, United States, 1974*

			Particular Doctor as Regular Source		
Family Income	*No Regular Source (%)*	*Place as Regular Source (%)*	*General Practitioner (%)*	*Pediatrician (%)*	*Other (%)*
Under $5,000	18.1	18.6	41.8	14.9	4.7†
$5,000-9,999	12.5	12.9	46.8	22.2	3.8
$10,000-14,999	7.2	8.5	48.8	29.6	4.0
$15,000 or more	5.8	7.4	44.4	36.3	4.4

*Source: Kovar and Meny [12, Table 27].
†Rows do not total 100 percent, because the source of care for some of the children is unknown.

private or military insurance (28.9 percent). When the family has an income of 150 to 199 percent of the poverty level, those who are uninsured are more likely to be without a regular source of care (13.3 percent). As is the case with the very poor, those who have no insurance or Medicaid are more likely to relate to a place without a regular physician than those with private insurance (31.8 percent and 34.7 percent versus 21.5 percent). Even when the family income is 200 percent or more of the poverty level, those who are uninsured are more likely to have no regular source of care than are those on Medicaid or those with private insurance. For this income group, as for the others, both those on Medicaid and those who are uninsured are more likely to relate to a place without a particular physician than are those who have private or military insurance. Therefore, individuals in each income group who are receiving Medicaid are less likely than those who are uninsured to be without a source of regular care, but they are at least equally likely to have a place rather than a particular doctor as their regular source of care [11, Table 28]. Table 8 also shows that being poor and being on Medicaid are associated with high proportions of children using hospital outpatient departments as their regular source of care. Dutton, in a study in Washington, DC, demonstrated that certain types of organizations, particularly those that provided poor continuity of care and that provided care primarily to poor people, achieved less satisfactory outcomes (such as fewer preventive services) than organizations providing greater continuity and serving heterogeneous populations [77].

Family income is directly associated with the likelihood that the child's last contact with a physician was in a private office, by tele-

Table 8: Children with No Regular Source of Care, and Some Characteristics of the Regular Source, by Family Income and Insurance Status of Children Under Age 17, United States, 1978*

Income and Insurance	*No Regular Source of Care*	*Place But No Particular Physician*	*Hospital Outpatient Department as Regular Source of Care*
150 percent or less of poverty level	9.6	34.2	10.5†
Private/military only	8.7	28.9	7.5
Medicaid	7.9	37.5	14.1
Uninsured	14.2	38.9	11.1
150–199 percent of poverty level	6.7	23.0	5.0
Private/military only	5.7	21.5	4.5
Medicaid	11.0	34.7	11.5
Uninsured	13.3	31.8	6.7
200 percent or more of poverty level	13.1	18.0	2.7
Private/military only	12.8	17.7	2.7
Medicaid	6.7	26.4	7.6
Uninsured	18.2	23.0	2.5

*Source: Kovar and Meny [12, Tables 28 and 30].
†The difference between 100 and the sum of each row is the percentage of children with other types of sources of care.

phone, or at home; it is indirectly associated with the likelihood that it was in a hospital outpatient department, emergency room, or other place [11, Table 75]. Low-income children are more likely to wait longer between visits than are upper-income children. Except for very poor children (income under $5,000, who are more likely to be receiving Medicaid), poor children have fewer contacts per year and fewer contacts per person per year than other children [11, Table 74]. Children in families with incomes of $5,000 to $9,999 are also distinguished by the high use of hospitals and low use of physician offices for injuries; 68.2 and 18.4 percent, respectively, as compared with children of higher incomes (about 42 and 32 percent, respectively) and as compared with children in families with incomes under $5,000 (56 and 34 percent, respectively), who are more likely to be covered by Medicaid [11, Table 77].

Low-income children are even less likely to have contact with a physician than other children if their greater illness is taken into

account. Controlled for morbidity, poor children have many fewer visits than nonpoor children [20].

There is a striking difference in insurance status between the poor and nonpoor, especially between those who are healthy and those who have functional disability due to chronic illness. Poor children without functional disability associated with chronic conditions are more than twice as likely to be uninsured as are nonpoor children. Poor children with severe illnesses, as measured by functional disability associated with chronic conditions, are almost three times as likely as similar nonpoor children to be uninsured [78]. Six times the proportion of poor children (1.7 percent, or almost 199,000 children) are disabled and uninsured as are nonpoor children, of whom 0.3 percent, or 188,000 children, are disabled and uninsured.

Evidence for the Benefits of Medical Care

What evidence is there that differences in access to medical care may be associated, at least in part, with the poorer health of the disadvantaged?

Although there is little doubt that long-term declines in mortality and improvements in health status result primarily from social and environmental advances, medical care has had an effect, as documented by evidence concerning reductions in the frequency of specific conditions after development of improved medical technology [79, 80].

To be effective, a technology must be applied where it is needed and in a way that permits it to accomplish its purpose. To what extent can medical care be demonstrated to be effective in preventing mortality and morbidity in childhood and therefore in modifying the impact of risk factors predisposing to illness?

The benefits of medical care were documented in a review of evidence concerning 16 different indicators of ill health in childhood [31]. Evidence was of two types:

- Temporal relationships between a change in the frequency or severity, or both, of a condition and a change in the nature or amount of health care delivered
- A finding that delay in seeking care is associated with more complications from or sequelae to illness.

Evidence of benefit was sought for the following: neonatal mortality, postneonatal mortality, low birth weight, adolescent childbearing, bacterial meningitis, diabetic ketoacidosis, asthma, appendicitis, immunizations and communicable diseases, congenital hypothyroid-

ism and phenylketonuria, gastroenteritis and dehydration, epilepsy, lead poisoning, iron-deficiency anemia, rheumatic fever, and child battering.

Evidence of benefit from medical care can be inferred from a variety of studies for specific conditions. In most cases, the evidence is sparse, indirect, and derived from studies that are uncontrolled or poorly controlled. For most of the conditions for which medical care is sought, evidence of effectiveness has not been documented by specific studies. Although there may be a few studies documenting the efficacy of particular modes of therapy, studies of their application under usual conditions of practice, including the extent to which various groups in the population have access to efficacious care as well as their usefulness when applied, are sparse. If the results can be generalized to other conditions, much, although by no means all, medical care can be said to have a beneficial effect; conversely, poorer access to medical care can be considered a risk factor for greater illness.

Effect of Medical Care in Reducing Risk Associated with Social Disadvantage

The ameliorating effect of medical care on the poorer health status of disadvantaged children is demonstrated by the following:

1. Hospitalization rates among poor children increased after access to medical care was facilitated in the mid-1960s; concomitantly, lengths of stay declined. The disparities between the poor and the nonpoor were thus much less than in the early 1960s [81, Figure 3].
2. Between 1960 and 1974, 16 additional poor children per 1,000 were diagnosed as having a chronic illness limiting their major activity; although diagnosed chronic illness also increased among nonpoor children, only 12 additional nonpoor children are now so diagnosed [81].
3. There is now better diagnosis of specific major chronic illnesses among poor children. Before the mid-1960s, a much lower proportion of poor children than nonpoor children was diagnosed as having diabetes. By the mid-1970s, almost equal proportions had diagnosed diabetes [31].
4. After programs such as Medicaid were established, the disparity in postneonatal mortality rate between the poor and the nonpoor narrowed [31].
5. In areas where access to better perinatal care was facilitated, the gap between the neonatal mortality rates of the poor and the nonpoor narrowed [31].

Summary of the Evidence on Medical Care as a Modifier of Risk for Illness

1. Poor children have less access to medical care, at least partly because of their poorer insurance coverage. When they receive care, it is likely to be from different types of sources, some of which are less adequate than those providing care to nonpoor children.
2. Medical care has been shown to be effective, at least for a number of childhood health conditions.
3. Providing better access to appropriate medical care can improve the health status of poor children. Poorer access to care is responsible, at least in part, for the greater severity of illness among poor as compared to nonpoor children.
4. Lack of access to timely and adequate medical care is clearly a risk factor for more severe illness in childhood.

BEHAVIORAL RISK FACTORS

Behaviors related to infant mortality include smoking, nutrition, alcohol use, drug use, maternal age, interpregnancy interval, and family development [82]. For mortality during childhood and youth, important behavioral variables include the use of restraints in automobiles, the use of motorcycle helmets, the use of alcohol, and driving habits in general. For suicide, relevant behaviors include warning responses, coping and adaptation behavior, and stress management. For homicidal behavior, variables include alcohol, and coping and adaptation [82].

Behavioral variables are also associated with child morbidity. For birth defects, behaviors include genetic counseling, amniocentesis, abortion, alcohol use, and drug ingestion. For injuries, relevant behaviors include water safety, traffic safety, auto restraint use, sports safety, home safety, and child care. For illnesses that can be prevented by vaccines, immunizations are critical. For sexually transmissible disorders, both sexual and treatment behavior are important. For dental caries, nutrition, oral hygiene, and fluoride use are all significant. For cardiovascular disease, relevant behaviors include smoking, nutrition, alcohol use, exercise, stress management, and coping and adaptation behaviors.

Teenage Parents

Teenage parenting is associated with a 25 percent increase in the risk of perinatal mortality [9]. The ratio of neonatal mortality among babies

born to mothers under age 18 compared with those born to mothers age 18 through 34, is 1.32 to 1 [49]. For postneonatal mortality, the ratio varies greatly with race. Compared with white mothers age 18 through 34, the ratios for neonatal mortality among babies born to mothers under age 18 are 1.10 to 1 for blacks and 1.43 to 1 for whites.

Clearly, perinatal mortality risks increase as maternal age declines. Above ages 15 to 16, it has been stated that "much of this increased risk can be eliminated by early prenatal care. Below this age there seem to be inherent biologic risks to pregnancy for which even medical care cannot compensate" [9].

Rates of low birth weight are known to be twice as high for infants of teenage mothers [9]. There is also an association between teenage parenting and child abuse or neglect. One recent study suggests that this association may be secondary to low income, which is itself associated with higher teenage parenting rates [83]. In that study, the proportion of mothers who gave birth as teenagers was higher in abusing families than in the general population. Other studies show that the level of social disorganization may be the most significant predictor of child abuse, not the age of the mother at the birth of the first child. The mechanism for this thus needs exploration in further research.

Alcohol and Marijuana Abuse

Abuse of alcohol and marijuana puts adolescents and young adults at risk of other addictions and dependencies and at risk of severe health consequences. These behaviors are of serious concern because of the rapid increases in the use of these substances that took place until the early 1980s. The health consequences are diverse, but the association of alcohol and marijuana abuse with the high rates of motor vehicle fatalities in these age groups is probably the most serious one.

Patterns of abuse. Both alcohol and marijuana grew in popularity among young persons in this country between the late 1960s and late 1970s, with some tapering off in the most recent statistics [84, 85, 86]. Research into personality aspects and sociodemographic variables has yielded only limited explanations of why particular young individuals begin to use these substances on a regular basis [82]. It is known that other, prior behaviors are strong predictors of drug abuse; for example, minor delinquent behavior is associated with alcohol and other drug use [88, 89, 85]. The use of marijuana and ethanol does not seem in itself to produce a craving for more potent and dangerous drugs, but it may increase contacts with persons who use and sell such drugs, thereby increasing the danger of abusing other substances [90].

Alcohol abuse. Ethanol is the most prevalent psychoactive substance now used by young adults [90]. Although it has proved difficult to document the extent of adolescent alcohol abuse, 1980 data show 3.5 million teenagers had "problems with alcohol" [91]. The transient course of most teenage alcohol ingestion means that complications of chronic alcoholism, such as cirrhosis, are generally absent in this age group. Rather, acute conditions, including gastritis, acute pancreatitis, severe central nervous system depression, and trauma, are most frequent [92].

Ingestion of small amounts of alcohol may have one beneficial effect: high-density lipoproteins increased with regular, moderate intake by adolescents [93, 62], although the differences in the latter study were not statistically significant. High-density lipoproteins may provide some degree of protection against coronary heart disease [93].

Marijuana abuse. Marijuana is capable of producing a dependency syndrome with clear abstinence symptoms, thus confirming the possibility of true physical dependence [94]. A variety of adverse effects have been documented, including: impairment of short-term memory, learning, and sense of time; anxiety attacks in a small proportion of users; impairment of lung function with heavy, prolonged use; and injuries secondary to impaired coordination, sensory and perceptual functions, and tracking [85, 90, 84]. There are also a number of syndromes that are associated with marijuana use but for which clear causal connections have not been established. These include the "amotivational" syndrome; adverse effects on the fetus of pregnant users, with no evidence of specific abnormalities; and increased delinquency, which appears to precede and predispose to drug use [88, 90, 85].

Cigarette Smoking

Cigarette smoking is declining for all age groups except adolescent women [95]. The onset of smoking is associated with the presence of peers, siblings, and parents who smoke [95, 62]. In addition to the long-term risks of lung cancer and other disorders, the relationship between smoking and coronary heart disease has been established. This is of particular concern in adolescence, since the incidence of hypertension and coronary heart disease is greatest and of earliest onset in individuals who begin smoking before the age of 20 [93]. It is now known that adolescents who are cigarette smokers have significantly lower concentrations of high-density lipoproteins than nonsmokers [96, 62].

Physical Condition

Many important questions regarding physical activity in children remain unanswered, including even whether aerobic training in prepubertal children produces a training effect [97]. At least one study (of 14 girls ages 8 to 10) showed a rise in high-density lipoproteins with an aerobic exercise program, but there has generally been inadequate study of the relationship between exercise and weight loss among obese adolescents and of the effects of exercise on smoking and hypertension [97].

Injury-generating Behaviors

A variety of behaviors is associated with an increased risk of childhood injuries. These include aggressive and dangerous behaviors in sports and in imitation of television heros, the purchase by parents and children of a variety of dangerous toys, and the use of fireworks. In addition, by putting more young drivers on the road, driver education programs appear to have increased automobile accidents and injuries among young adults. Some obvious behaviors that result in increased risk are failure to use auto seat restraints and motorcycle helmets [75].

Nutritional Choices

By children. Serious morbidity and mortality related to poor nutrition are uncommon in this country. Only 9 percent of primarily low-income children in 1978 were below height standards for their ages, and only 6 percent were below weight for their ages [11].

Adolescents exhibit a variety of food behaviors that have caused concern. These include skipping meals; snacking, especially on sweets; frequent eating of fast foods; choosing unconventional foods for certain meals; drinking large amounts of soft drinks; consuming occasional huge meals; and sporadic dieting. Yet the reason for this concern is unclear, since youths now exhibit remarkable growth and fitness. Certain specific disorders in adolescence do warrant attention, however, such as obesity (among 10 to 20 percent of adolescents, with high rates of anxiety about weight), alcohol abuse, anorexia nervosa (1 percent of girls), low intake of iron, and high fat consumption beyond the end of adolescence [98]. In addition, there are serious dental risks related to nutrition.

High fat consumption may raise the risk of coronary heart disease. There are no longitudinal data to establish that childhood hypercholesterolemia increases the risk of coronary heart disease in adulthood, but

many authors cite "extensive indirect evidence of such a relationship" [93]. Concentrations of high-density lipoprotein cholesterol may have a more significant role than total concentration of cholesterol in predicting coronary risk. Some of the evidence for a link between childhood lipid levels and coronary artery disease is based on the thirtyfold increase in risk of premature myocardial infarction in individuals suffering from the specific dominant genetic disorder of hypercholesterolemia with xanthomatosis (type II). In addition, most young men suffering a myocardial infarction are found to have hypercholesterolemia [99]. Although the ability to lower concentrations of lipids in the blood through diet has led some to promote dietary intervention [61], the safety as well as the efficacy of such dietary interventions is open to question, particularly if the object is to lower the general population's risk of coronary heart disease [62, 99].

Low intake of iron has a number of health consequences, even in the absence of iron-deficiency anemia. Iron-related problems are still very common in this country. Approximately 14 percent of children have low hemoglobin, and 18 percent have a low hematocrit. About 50 percent of low-income children age 12 to 23 months have less than one-half the normal concentrations of iron; the corresponding figure in the higher-income group is about 30 percent [101].

Iron deficiency has been shown to be associated with behavioral and cognitive changes that are not correlated with the severity of the anemia itself. These include lower composite achievement scores, with boys progressively worse over time [101], and more severe disturbances of conduct than among nonanemic controls of the same age [102]. The irritability and lassitude associated with iron deficiency are reversible with iron therapy, even before sufficient concentrations of iron status and hemoglobin mass are restored [103]. Children deficient in iron at age 3½ years demonstrated decreased attention and memory process variables, with no changes in behavioral structural capacity; these differences were reversible with iron therapy [104]. Iron deficiency, with or without anemia, has now been shown to result in low Bayley Mental Development Index scores, which are also reversible with iron therapy [105].

Poor nutritional status places children at increased risk of dental diseases. Children age 3 through 4 are at risk for the "nursing bottle syndrome," with erosion of teeth [106]. The first National Health and Nutrition Survey examined the relationship between diet and dental disease in some detail. No relationship was found between overall quality of diet or percentage of total calories from sweets and the number of decayed, missing, or filled teeth. A definite relationship was

found between the percentage of total calories from between-meal sweets and the number of decayed, missing, or filled teeth. The most important relationship, however, was between the frequency of between-meal sweets and the number of decayed, missing, or filled teeth. The frequency of other snacks was not associated with decayed, missing, or filled teeth [56].

Malnutrition has been shown to produce behavioral changes which, together with poor socioeconomic status and poor infant stimulation, may result in decreased intellectual development [100]. After reviewing the literature, Pollitt and Leibel [103] concluded that "severe protein-calorie malnutrition occurring during a period of rapid brain growth is likely to result in anatomic and biochemical alterations of that organ and moderate retardation of intellectual function."

Malnutrition has also been shown to affect both the immunological and nonspecific bases of host defenses; a particularly important effect is on cell-mediated immunity [100]. In addition, disturbances of the mother-child interaction, especially when centered around nutrition, are known to result in the failure-to-thrive syndrome [100].

Maternal nutritional choices during pregnancy. The relationship between maternal nutrition during pregnancy and newborn morbidity and mortality has been well established in situations in which maternal food deprivation is extreme, such as wartime. In such cases, starvation is clearly not a behavior, since the mother has no choice. As one considers moderate differences in diet that are at least partially the result of maternal choices, the relationship of diet to newborn outcome becomes somewhat less clear, but evidence still suggests strongly that nutritional supplementation may reduce infant mortality and morbidity.

Supplementing the diets of Guatemalan women by an average of 1,500 kilocalories per day during pregnancy was associated with improved infant mortality [107]. One major review concludes that, where maternal diets consist of fewer than 1,800 kilocalories per day, food supplementation in pregnancy generally results in increased average birth weight, lower rates of low birth weight, and decreased perinatal and infant mortality [108]. In other, less extreme social settings, the effect of food supplementation is less clear [108, 106].

Recent analyses of data on the more than 50,000 singleton pregnancies represented in the U.S. Collaborative Perinatal Project have provided strong evidence that maternal nutrition is closely associated with neonatal morbidity and mortality. Low birth weight was strongly correlated with the mother's net weight gain during pregnancy when mothers were underweight before becoming pregnant. The relation-

ship was particularly clear in women who had been less than 83 percent of the desirable weight for their height before pregnancy [109].

A relationship between maternal nutrition and neonatal mortality was also established. When mothers were stratified according to the degree to which their prepregnancy weight was desirable for their height, those with weight gains of less than 54 percent of optimal values had significantly higher perinatal mortality rates in every weight category except obesity. Heavier women had higher mortality rates only when their weight gain was less than 25 percent of the desirable amount. Although a wide variety of seemingly unrelated disorders was responsible for the excessive mortality, the presence of excess mortality in low-weight-gain pregnancies was strongly associated with maternal acetonuria, a marker for increased catabolism of fat and sometimes metabolic acidosis [109, 110].

Starfield has reviewed a variety of efforts to influence infant health through nutritional supplementation and counseling [32]. Within individual maternal and infant care projects, there was a significant inverse correlation between nutritional advice availability and low birth weight rates [112]. Nutritional supplements also were found to result in lower rates of low birth weight [113]. A prospective study of nutritional supplementation among black women in New York City, however, yielded no impact on low birth weight [114]. Further, there is no evidence to support the common practice of giving vitamin and iron supplements during pregnancy.

One of the major programs aimed at improving nutritional status during pregnancy is the special supplemental program for Women, Infants, and Children (WIC). Reviewing evaluations of WIC, Starfield noted that they failed to provide conclusive evidence of effectiveness but that three studies did show some effect. In one, there was a small increase in birth weight with supplementation for more than 3 months, although none was found with less supplementation [115]. In another WIC program, participants had increased average birth weights compared with non-WIC births, even after controlling for socioeconomic status, use of prenatal care, nutrition and smoking counseling, and other maternal characteristics [116]. A third study found that mean birth weights were increased but only a small, and not statistically significant, amount [117].

In sum, in extreme cases, poor nutritional status clearly affects the outcome of pregnancy and increases the risk of perinatal mortality and newborn morbidity. Although the risks associated with moderate levels of deprivation (and, correspondingly, moderate levels of supplementation) have proved difficult to define, most authors believe that evidence

strongly suggests some benefit from supplementation and the creation of increased risk from nutritional inadequacy. The evidence is strong enough that King [100] estimated that 5 percent of babies born, some 114,000 per year, are small for their gestational age because of inadequate nutrition and that 16,000 to 17,000 are born early or die because of poor nutrition *in utero*.

ENVIRONMENTAL RISK FACTORS

An overall summary of health status and risk factors can hope to identify only the most general phenomena. This is especially true with regard to environmental factors, which are numerous and diverse in their effects. Conditions of living and working are of prime importance in the genesis of some diseases; for others, the environment plays an influential role. In the former category are problems arising from exposure to toxins, infectious agents, excessive noise, radiation, unsafe housing, and neighborhoods and living conditions that do not provide adequate heat, light, refrigeration, or ventilation. Occupational hazards to which parents are subject may also have adverse effects on children, as demonstrated by lead poisoning in children of individuals who work in industries involving contact with lead.

Environmental factors may also predispose to illness. Such factors include (but are not limited to) the following: residence (urban or rural area, region); environmental exposures, such as household hazards; poorly designed equipment; traffic hazards; and poorly monitored places, such as swimming pools. Other environmental conditions reduce risk. These include (but are not limited to) fluoridation of water and legislative or administrative control over commercial products.

Data collected routinely by the National Center for Health Statistics contain information about area and region of residence.

Residence

Infant mortality rates vary with residence (metropolitan or nonmetropolitan), but the nature of the relationship may be changing over time. Total infant mortality rates and rates for most specific causes of death were higher in urban than in rural areas well into the 1960s [13]. This differs by age, with neonatal rates lower in rural areas and postneonatal rates lower in urban areas.

Mortality rates for children differ from those for infants. For children age 1 through 4 and 5 through 14, they were 22 percent higher in nonmetropolitan than in metropolitan areas [13]. This seems to be

related to higher rates of infectious diseases and accidental death in nonmetropolitan areas.

Geographic Region

Infant mortality rates are generally lowest in New England and highest in the south central United States. It has been suggested that these differences are "a reflection of the comparatively poor regional socioeconomic conditions, especially for the black population" [13, p. 474]. The infant mortality rate is also higher in mountain regions. The same authors suggest that this is due to fetal hypoxia, producing lower birth weights.

Mortality rates for children ages 1 through 4 and 5 through 14 also vary by geographic region. As with the infant mortality rate, regional differentials and total childhood mortality tend to reflect racial differences [13]. The rates are highest in the east south central and lowest in New England regions.

General Environment

Studies of the frequency of neural tube defects in different populations show how environment can increase the risk of illness. These defects are known to be low in native Japanese and high in native Britons; however, they are higher for Japanese who moved to Hawaii and lower for the British who moved to areas of low prevalence [59]. The implication on further analysis is that the environment plays some, but not the only role: Japanese who migrate have lower rates than Caucasians living in the same areas. Correspondingly, British immigrants have higher rates than do natives of the new areas. The shift in rates is gradual and is most marked in descendants of the immigrants.

Environmental Risks for Injuries

Although the environment often acts as a risk factor for many "biomedical" types of disease, its effect is most obvious in the case of injuries, which are the largest single cause of mortality and morbidity in children. The combination of factors that contribute to trauma and determine its effects has been conceptualized by Haddon [3] and adopted by others. The three types of factors involved in trauma are (1) those that are under human control, (2) those that intervene as a vehicle or vector, and (3) those that exist in the physical and socioeconomic environment. Each of these types can operate before the event, during the event, or after the event to increase or reduce the harmful effect.

Several recent reviews of childhood injuries have employed this conceptual scheme to demonstrate its usefulness in increasing knowledge about the cause and control of injuries. In particular, they have shown the critical importance of factors in the environment that are often beyond the control of the individuals involved but that are amenable to modification by intervention at the community or larger social level. Because the scheme facilitates consideration of the multiplicity of factors that contribute to the genesis and manifestations of ill health, its application to research on other, more traditional categories of health problems may be fruitful.

Starvation

Studies of wartime conditions showed an effect on birth weight as well as on infant mortality [106]. The Seige of Leningrad, wartime records from Wuppertal, Germany, and the famine in Holland all provided evidence of reduced mean birth weight. It must be noted that other factors which could affect birth weight, such as non-nutritional wartime stresses and selective fecundity brought about by amenorrhea, were also present. Because non-nutritional stresses were considered to be less severe in Holland than in Leningrad, it is believed that nutritional variables played a major role in the reduction in mean birth weight [118].

Maternal Radiation During Pregnancy

Some 33,000 pregnant women, about 1 percent of all pregnancies, receive abdominal x-rays. The dosage received by the embryo or fetus of 12 patients in one series ranged from 0.3 to 3.5 rad, well below the 10 rad estimated as necessary to increase the risk of congenital malformations, growth retardation, or fetal death. The lower level, however, may still be high enough to produce teratogenic or mutagenic effects, some of which may not become apparent for many years. The risk of such effects is estimated to be about 1 per 1,000 live births per rad: thus, those 12 patients experienced risks ranging from 1 per 3,000 to 1 per 300 [119].

ACKNOWLEDGMENT

We would like to express our appreciation for the extensive and highly constructive comments provided by the reviewers of the first draft: John Butler, Gordon DeFriese, Bob Haggerty, Elena Nightingale, and

Arden Miller. We are also grateful to Alice Hersh for her encouragement and forbearance. Special thanks are also due to Maggie Hall for editing, typing, and patience.

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